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Background Document

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The purpose of this "Background Document" is to provide information to support the report entitled "The Solid Waste Dilemma: An Agenda for Action." The Agenda for Action describes for municipal solid waste situation in this country, and presents a strategy to improve the management of these wastes nationwide. However, the strategy report only presents the analysis behind its recommended actions in a summary fashion. It is left to this Background Document to develop the background data on the problem, and develop the arguments for alternative solutions more completely.

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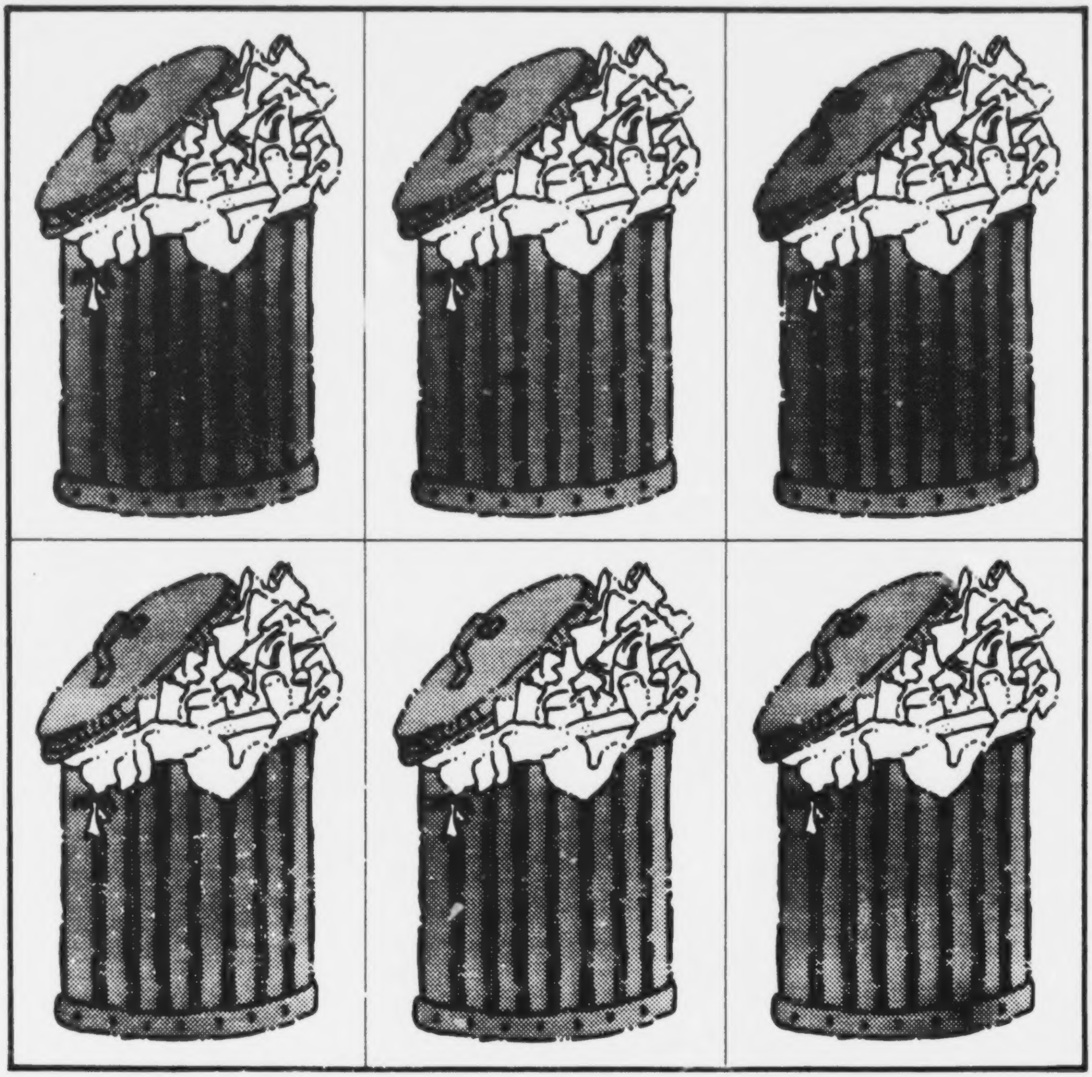

Draft Report
of the Municipal Solid Waste Task Force
Office of Solid Waste
United States Environmental Protection Agency
September 1988

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BACKGROUND DOCUMENT
FOR

THE SOLID WASTE DILEMMA: AN AGENDA FOR ACTION

Draft Report of the Municipal Solid Waste Task Force

Office of Solid Waste

U.S. Environmental Protection Agency

August 1988

INTRODUCTION

The purpose of this "Background Document" is to provide information to support the report entitled "The Solid Waste Dilemma: An Agenda for Action." The Agenda for Action describes the municipal solid waste (MSW) situation in this country, and presents a strategy to improve the management of these wastes nationwide. However, the strategy report only presents the analysis behind its recommended actions in a summary fashion. It is left to this Background Document to develop the background data on the problem, and develop the arguments for alternative solutions more completely.

The context in which this Background Document was developed was an intensive ten week effort by the Municipal Solid Waste Task Force, between April 15 and July 1, 1988. It is a compilation of existing materials, ideas and options developed by those participating in the project. It is not meant as any statement of EPA policy, and should not be construed as such. Within this context, it is important to understand what the Background Document is, and what it is not.

What the Background Document Is

- It is a description of the magnitude and nature of MSW generation and the characteristics of MSW in the U.S. from 1960 to 1988, with forecasts through the year 2000.
- It is a discussion of the current waste management practices in this country, including source reduction, recycling, composting, combustion, and landfilling, and their adequacy from environmental, economic, and societal points of view.
- It is a discussion of the obstacles that have been identified by many concerned parties that exist to the

consideration and use by communities of an "integrated waste management" scheme; the increased use and effectiveness of source reduction, reuse, recycling, and composting; and the improvement of all existing waste management practices.

- It is a description of options that were raised by those participating in this effort to overcome these obstacles and upgrade the nation's MSW management situation. Not all of these options were selected in constructing the Agenda for Action, but it is useful to examine the complete set of options and their pros and cons.

- It includes a description of potential research, development, and demonstration activities to provide data to facilitate solutions to the MSW management dilemma.

- It includes a series of Appendices that largely present summary information on various components of the MSW stream, as well as other wastes often associated with MSW. The information provided on these wastes and components includes quantity and characteristic data, conclusions from the application of various waste management practices, the identification of notable issues or problems, and other data.

What The Background Document Is Not

- It is not an exhaustive study of the MSW technologies and practices, nor is it an exhaustive discussion of the MSW stream components or associated wastes.

- It is not an exhaustive cost/benefit analysis of all issues and options, such that the identified options (as well as those chosen for inclusion in the "Agenda for Action") can be quantitatively linked to precise cost or benefit improvements.

- It is not an extensive investigation of the details of implementation of various options for improving MSW management. Therefore, information on budgets, precise schedules, and staffing is not included.

- It does not, in all cases, include all possible data sources, but only those which could be accessed during the ten week developmental period.

The Task Force is still seeking improved data on some of the issues, and would welcome receiving such from any reviewers of this Background Document, so that, in its final form, it can represent the MSW factual basis for decision-making as accurately as possible.

Another important point is that over 50 peer reviewers from environmental groups, associations of state and local government, trade associations, and industry groups were involved in the development of the Background Document. They have had an opportunity, albeit on an extremely compressed schedule, to review all of the sections of this report. While not all of their comments were incorporated in this draft, all major comments were seriously considered and many changes made as a result of them. In an effort to continue the broad involvement of all interested parties, there will be a series of public meetings and a public comment period in the fall of 1988 to incorporate other constructive suggestions.

Together, the Agenda for Action and this Background Document take a broad national perspective on the implementation of recommendations which need to be accomplished by Federal, State, and local governments, industry, and individual citizens. Therefore, the entire report is far more than an agenda for action by EPA, although its leadership role is an important part of the strategy. It is an agenda for action for the entire nation.

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DEFINITIONS

1. ASH:

A residue from the process of burning solid waste or solid waste-derived fuels. Bottom ash is the residual of the combustion process collected from the bottom of the furnace. Fly ash is residual matter removed from the effluent gas stream by an air pollution control device.

2. COMPOSTING:

The controlled degradation of organic materials by biological means into a humus-like substance that can be used as a soil amendment.

> Solid Waste Composting - The controlled degradation of municipal solid waste that is pre-sorted to remove non-compostable inorganic materials.
>
> Yard Waste Composting - The controlled degradation of leaves, grass, tree trimmings, and brush.

3. DESIGNING FOR EFFECTIVE WASTE MANAGEMENT:

The design and manufacturing of products considering the waste management characteristics, including volume, toxicity, recyclability, and degradability of the product.

4. DROP-OFF:

A method of collecting recyclable and/or compostable materials. Instead of a separate collection, recyclables and/or compostables are self-hauled to collection sites.

5. INCINERATION:

A controlled combustion process where municipal solid waste is burned to reduce volume and, commonly, to produce energy.

Mass Burn - The combustion of municipal solid waste without prior sorting or processing in a controlled system normally fabricated on-site.

Modular - A shop-fabricated combustion system.

Refuse-Derived Fuel - A fuel produced from processed municipal solid waste. RDF can be burned with or without other fuels, such as coal, in a variety of forms (shredded, fluff, densified pellets, etc.).

6. INTEGRATED WASTE MANAGEMENT:

The complementary use of a variety of waste management practices to safely and effectively manage the municipal solid waste stream. An integrated waste management system will contain some or all of the following components:

- Source reduction (including reuse of products)
- Recycling of materials (including composting)
- Combustion (with or without energy recovery)
- Landfilling

In general, a hierarchy of these waste management options should be considered: source reduction and next recycling should be used to the extent feasible to reduce the volume and toxicity of waste requiring management by the two lower options--combustion and landfilling. However, each community must custom-design its integrated waste management system to meet its local needs.

7. ORGANIZED COLLECTION:

A system of collecting municipal solid waste where refuse haulers collect from certain zones or districts instead of overlapping routes.

8. RECYCLING:

A process involving: separation of a material from the waste stream; collection (before or after separation); processing; marketing; and utilization of that waste material as the raw material for products which may or may not be similar to the original.

9. RESIDUALS:

Materials remaining after processing, incineration, composting, or recycling. For example, ash is a residual of the incineration process.

10. RESOURCE RECOVERY:

The process of extracting useful materials or energy from municipal solid waste. There are two primary types:

Materials Recovery - Extracting useful materials from solid waste by way of processing.

Energy Recovery - Extracting useful energy from solid waste by way of combustion.

11. REUSE:

The use of a product more than once in its same form for the same purpose thereby reducing the amount of waste generated. For example, a soft-drink bottle is reused when it is returned to the bottling company for refilling.

12. SANITARY LANDFILL:

A land disposal technique in which solid waste is disposed on the smallest practical working face of a series of cells. Daily or periodic application of cover material is required and the facility is designed and operated in such a manner so as to minimize environmental contamination.

13. SELF-HAUL:

The transport of waste materials by individual residents or businesses directly to transfer stations, recycling centers, incinerators, compost facilities, or other processing or disposal sites.

14. SEPARATE COLLECTION:

Collection from households of recyclable or compostable materials that have been separated prior to collection.

Specialized refuse vehicles are often used for this type of collection.

15. SLUDGE:

A semi-liquid residue remaining from the treatment of municipal and industrial water and wastewater consisting of suspended solids combined with water and dissolved material in varying amounts.

16. SOLID WASTE:

Any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. Solid waste does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended, or source, nuclear, or by product material as defined by the Atomic Energy Act of 1954, as amended.

17. SOURCE REDUCTION (Also called WASTE REDUCTION):

The design, manufacture, acquisition and reuse of materials including products and packaging, so as to minimize the quantity and/or toxicity of waste produced. Source reduction prevents waste either by redesigning products or by otherwise changing societal patterns of consumption, use, and waste generation.

18. SOURCE SEPARATION:

The segregation of specific waste materials at the point of discard for separate collection.

19. WHITE GOODS:

Large metal appliances such as refrigerators, stoves, clotheswashers and dryers, dishwashers, air conditioners, water heaters, and freezers.

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CHAPTER 1

CHARACTERIZING THE WASTE STREAM

A. QUANTITIES AND TYPES OF WASTE

This chapter presents an overview of municipal solid waste (MSW) and other wastes that are typically co-managed with MSW. Municipal solid waste is the term used to represent the agglomeration that appears daily and relentlessly at the threshold of every municipal solid waste landfill, incinerator, and processing facility across the nation. The nature of this mixture is variable, affected by factors such as time, location, season and climate, demography, and local practices, all of which are beyond the control of the waste management facility. The pattern of variability for each municipality, however, can be determined locally.

In addition to municipal solid waste, other wastes such as municipal sludges and demolition wastes are often co-managed with MSW, especially at municipal landfills. Although not the primary focus of this report, these wastes are also characterized briefly.

1. MUNICIPAL SOLID WASTE

Municipal solid waste includes wastes from household, institutional, commercial, municipal, and industrial sources. These sources can be characterized as follows.

Residential: Wastes from single and multiple-family homes. When multiple-family units exceed four, these wastes are usually collected in large containers by commercial haulers. These wastes are often called household wastes.

Institutional: Wastes from schools and colleges, hospitals, prisons, and similar public or quasi-public buildings.

Commercial: Wastes from retail stores, shopping centers, office buildings, restaurants, hotels, airports, wholesalers, auto garages (including tires and batteries) and other commercial establishments.

Municipal: Wastes generated by municipal public works, such as street sweepings and tree and brush trimmings.

Industrial: Wastes such as corrugated boxes and other packaging, cafeteria wastes, and paper towels from factories or other industrial buildings. The term does not include waste from industrial processes, whether hazardous or nonhazardous.

The definition of municipal solid waste is general, and the boundaries separating the sources above are vague. For example, a government office building could be considered either an institutional or a commercial source. These loose definitions make analysis of existing data difficult. Also, it is the point of discard or the agency responsible that determines how a waste is classified. For example, tree trimmings disposed of by a commercial tree-trimming service could have originated from a residential, commercial, or institutional source.

2. OTHER SOLID WASTES COMMONLY CO-MANAGED WITH MSW

In addition to municipal solid waste, other wastes that are often landfilled, incinerated, or otherwise handled or processed along with MSW are briefly described below. These wastes are generally not well characterized and are not included in the statistical data that follow this section.

Municipal Sludges: These wastes include water and wastewater (sewage) treatment sludges. Over 40 million tons of wastewater sludges are disposed of in the United States every year by incineration, land spreading, and landfill. Up to 8 million tons of water treatment sludge are disposed of each year.

Municipal Waste Combustion Ash: Over 3.8 million tons of residues from the combustion of MSW are disposed every year, mostly in MSW landfills.[1]

Industrial Wastes: An estimated 430 million tons of nonhazardous industrial wastes are generated each year. Much of this waste is managed onsite by the generating industries, but some is landfilled at MSW landfills. Some nonhazardous industrial wastes that may arrive at a MSW landfill are fiberglass, sand moldings, catalysts, sludges, contaminated soil, and the like.

Construction and Demolition Wastes: These wastes include lumber, roofing, broken concrete, asphalt, glass, wallboard, piping, asbestos, etc. Estimates are variable, but probably about 32 million tons are disposed of each year. Some goes to MSW landfills, some to demolition landfills.

Household Hazardous Wastes and Very Small Quantity Generator Wastes: Finally, there are two waste categories that meet the criteria for hazardous wastes to be managed under Subtitle C of the Resource Conservation and Recovery Act (RCRA)--household hazardous wastes (HHW) and very small quantity generator (VSQG) wastes. They are, however, treated as Subtitle D wastes. These wastes have generally been going to MSW landfills.

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[1] U.S. Environmental Protection Agency. Report to Congress: Solid Waste Disposal in the United States, April 15, 1988.

3. QUANTITIES AND SOURCES OF MSW

The database for this chapter is derived principally from the Franklin Associates, Ltd. reports which describe the methodology and data development. The basic methodology is a mass balance of materials flow approach developed at EPA in the early 1970's. The data are derived from published data series of production and consumption of materials and products that enter the municipal solid waste stream. Adjustments are made for imports and exports where appropriate and also for diversion from the solid waste stream, e.g., books in libraries, toilet paper disposed in sewers, construction products, the life cycle of furniture and appliances, etc. Deductions are also made for converting materials lost in manufacturing processes; these are generally recycled as industrial scrap. The only components of MSW developed from actual sample data are food wastes, yard wastes, and miscellaneous wastes.

The result of these adjustments gives a "gross discard" value. Then, a further deduction is made for the recovery and recycling of postconsumer products such as newspapers, aluminum cans, glass bottles, plastics, etc. A further adjustment is made for volume and weight reduction from incineration. The final results of the calculations are "net discards," representing those wastes presumably going to MSW landfills.

It is important to note that the methodology produces only a national perspective and only for those principal components of MSW for which a historical data series could be developed. Also, the net discards are only estimates of the amount of waste in MSW systems without regard to whether the wastes are collected, littered, or self-disposed. Finally, some significant categories of waste that may be disposed along with MSW are excluded from consideration. A broad generalization is that national average per capita MSW discards on the one hand understate the quantity that must be handled at MSW systems in densely-populated metropolitan areas of the country with substantial industrial and commercial activity and, on the other hand, overstate them in areas of low population density and rural areas.

The generation of MSW (excluding municipal sludges, ash, industrial process wastes, construction, and demolition wastes) has grown from 87.5 million tons in 1960 to nearly 158 million tons in 1986 (see Table 1-1 and Figure 1-1). In the absence of drastic changes, this will increase by 25 percent, to nearly 193 million tons in the Year 2000. Things are not quite so bad as those numbers would indicate--combined materials and energy recovery reduced the net discards of MSW to landfills and incinerators to 131 million tons in 1986, with a projected 137 million tons in 2000.[2] Since most of those discards will probably be landfilled, however, there are significant issues to address.

There are two ways to characterize the MSW stsream--by material and by product. The EPA characterization study includes data arranged in both ways.

a. Materials in MSW

An overview of the materials in MSW is shown in Figure 1-2 and Table 1-2. Paper and paperboard is the largest materials category, at 41 percent of total gross discards in 1986. Yard wastes are second, at 18 percent of total MSW. Glass; metals; plastics; rubber, leather, textiles, and wood combined; and food

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[2] Note: It is not clear at this time whether ash will be treated as a special waste, as MSW, or as some other waste category. Therefore, ash was not added back to net discards of MSW (see Table 1-1). However, ash must be landfilled or otherwise disposed of. The quantity of ash in this status is as follows: 1970, 0.1 million tons; 1986, 2.4 million tons; and 2000, 8.0 million tons.

TABLE 1-1

GROSS DISCARDS, RECOVERY, AND NET DISCARDS OF MUNICIPAL SOLID WASTE

(In millions of tons)

	1960	1970	1986	2000
Gross Discards	87.5	120.5	157.7	192.7
Materials Recycling	5.8	8.0	16.9	23.9
Energy Recovery	-	0.4	9.6	32.0
Net Discards	81.7	112.1	131.2	136.8

Source: Franklin Associates, Ltd., 1988.

wastes are similar in percentages of the total, ranging from 6.5 percent for plastics to 8.7 percent for metals.

b. Products in MSW

Products are classified as durable goods, nondurable goods, and containers and packaging (see Table 1-3 and Figure 1-3). Durable goods made up about 12 percent of MSW in 1986. The chief components of this category are major appliances, furniture and furnishings, rubber tires, and miscellaneous items such as small appliances and electronics.

Nondurable goods made up about 26 percent of MSW in 1986. Paper products such as newspapers, office papers, tissue papers, and paper plates and cups account for the majority of nondurable goods. This category also includes clothing, footwear, and

FIGURE 1-1

GROSS DISCARDS, RECOVERY, AND NET DISCARDS OF MSW

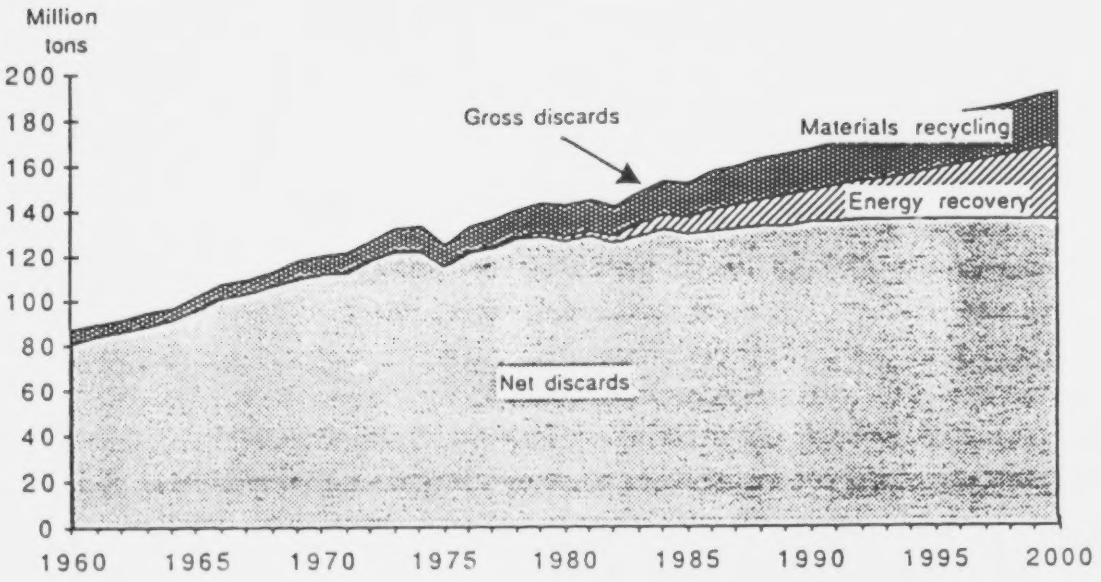


FIGURE 1-2

GROSS DISCARDS OF MSW MATERIALS, 1986

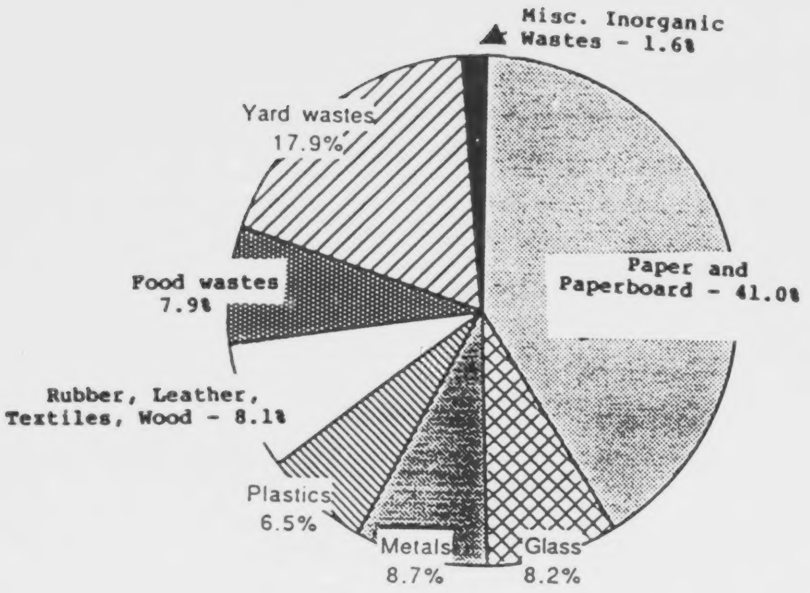


TABLE 1-2

GROSS DISCARDS* OF MATERIAL IN MSW
(In millions of tons)

Materials	1960	1970	1986	2000
Paper and paperboard	29.8	43.9	64.7	86.5
Glass	6.5	12.7	12.9	13.4
Metals	10.5	13.7	13.7	15.9
Plastics	0.4	3.0	10.3	15.7
Rubber, Leather, Textiles, Wood	6.8	9.3	12.6	13.4
Food Wastes	12.2	12.8	12.5	12.3
Yard Wastes	20.0	23.2	28.3	32.0
Miscellaneous Inorganics	1.3	1.9	2.7	3.3
Totals	87.5	120.4	157.7	192.6

---

* Before materials recovery for recycling.

Source: Franklin Associates, Ltd., 1988.

TABLE 1-3

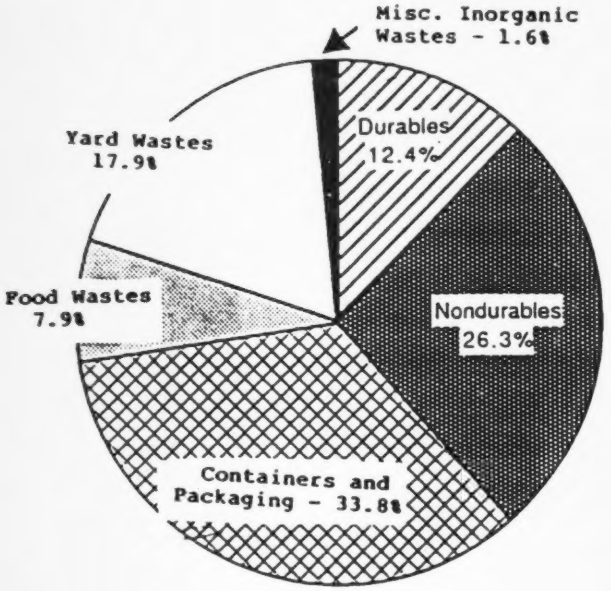
GROSS DISCARDS OF PRODUCTS IN MSW
(In millions of tons)

Products	1960	1970	1986	2000
Durables	9.4	14.3	19.5	23.6
Nondurables	17.5	25.2	41.4	56.4
Containers and Packaging	27.1	43.1	53.3	65.1
Food Wastes	12.2	12.8	12.5	12.3
Yard Wastes	20.0	23.2	28.3	32.0
Miscellaneous Inorganics	1.3	1.9	2.7	3.3
Totals	87.5	120.4	157.7	192.6

Source: Franklin Associates, Ltd. (3).

FIGURE 1-3

GROSS DISCARDS OF MSW PRODUCTS, 1986



miscellaneous plastic items.

Containers and packaging are the largest product category in MSW, making up almost 34 percent of gross discards in 1986. By weight, paper and paperboard constitute almost 55 percent of containers and packaging gross discards. The other packaging materials, in order by weight discarded, are glass, plastics, steel, wood, and aluminum.

c. Discards by Individuals

Another interesting way to look at generation of MSW is in terms of generation per person. Gross discards per person are increasing steadily, from 2.65 pounds per person per day in 1960 to 3.58 pounds per person per day in 1986. The estimate for the Year 2000 is nearly 4 pounds per person per day (Table 1-4).

Materials recycling and energy recovery, if practiced at the modest levels indicated by current trends, will reduce net discards per person from almost 3 pounds per person per day in 1986 to 2.8 pounds per person per day in 2000. The figure will be essentially flat at 3 pounds per person per day if the incinerator ash is added back to net discards.

d. Current MSW Disposal

MSW can be managed by a hierarchy of methods: reduction/reuse, recycling, combustion with and without energy recovery, and landfilling. Estimates of solid waste management practices in 1986 are shown in Table 1-5 below.

TABLE 1-4

GROSS DISCARDS, RECOVERY, AND NET DISCARDS OF MUNICIPAL SOLID WASTE

(In pounds per person per day)

Products	1960	1970	1986	2000
Gross Discards	2.65	3.22	3.58	3.94
Materials Recycling	0.18	0.21	0.39	0.49
Energy Recovery	-	0.01	0.22	0.65
Net Discards	2.48	3.00	2.98	2.80

Source: Franklin Associates, Ltd., 1988.

TABLE 1-5

CURRENT MSW MANAGEMENT PRACTICES, 1986

	Million tons per year	Percent
Material Recycling	17	11
Combustion with Energy Recovery	10	6
Combustion without Energy Recovery	5	3
Landfilling, Other	126	80
	158	100

Source: Franklin Associates, Ltd., 1988 and EPA, 1986.

Materials recycling reduced the amount of waste requiring disposal by 11 percent in 1986, while combustion with and without energy recovery accounted for 9 percent of the MSW. Finally, 80 percent of MSW was disposed of by landfilling or other means. A small amount of that was ocean disposal, and an unknown amount became litter or was otherwise improperly disposed.

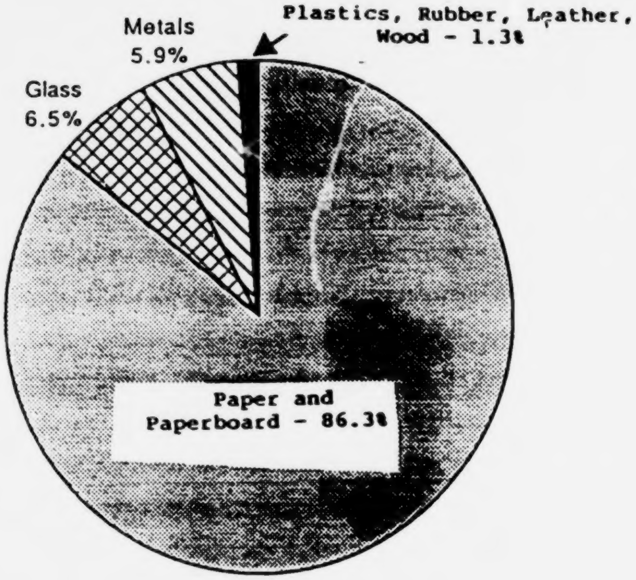
(1) Materials Recycling

Materials recovery for recycling has increased from 5.8 million tons in 1960 to 16.9 million tons in 1986 (Table 1-1). Recovery is projected to increase to 23.9 million tons in 2000 if current trends continue.

Paper and paperboard represent over 86 percent of the tonnage of materials recycled in 1986 (Figure 1-4). Glass and metals recovery are 6.5 percent and 5.9 percent of total

FIGURE 1-4

MATERIALS RECYCLING IN 1986
(as a percent of total recycling)



recycling, respectively. All other materials recovered are only 1.3 percent of the total.

(2) Municipal Waste Combustion

Combustion without energy recovery has long been practiced, but many incinerators have been shut down for a variety of reasons, including high maintenance and operating costs, air pollution control regulations, objections by nearby residents, and generally unfavorable economics compared to other solid waste management alternatives. Combustion of MSW for energy recovery began in the late 1960's, with significant amounts of MSW beginning to be consumed in the 1980's. Subtraction of incinerated tonnage lowers the net discards to be landfilled to 131.2 million tons in 1986, with projected net discards of 136.8 million tons in 2000 (Table 1-1).

(3) Combined Effects of Materials and Energy Recovery

As Figure 1-1 illustrates, the combined effects of materials and energy recovery cause the net discards to stay more or less "flat" after 1986. On a per capita basis, the combined effect of materials and energy recovery causes the pounds per person per day to "flatten out" in the 1980's and decline in the 1990's (Table 1-4).

The estimates of materials and energy recovery used here are fairly conservative, representing a continuation of current trends. There is, therefore, the possibility that net discards can be reduced further if the levels of recycling and energy recovery are increased.

(4) Landfilling and Other Disposal

Nearly all of the net discards after materials and energy recovery are landfilled, with relatively small amounts being combusted without energy recovery, ocean disposed, or littered. Landfilling will be with us indefinitely. Even with strenuous efforts devoted to source reduction, recycling, and incineration, landfills will still be needed for nonrecyclable materials and incinerator ash. EPA's Report to Congress shows that there are about 6,000 operating landfills today.[3]

e. Generator Classifications and Quantities

EPA's national data base estimates that about 3.6 pounds per person per day of MSW were generated in 1986. After deductions for materials and energy recovery, the amount to be disposed of is about 3 pounds per person per day.

No reliable national numbers on per capita MSW generation by residential and commercial sources are available. However, it is generally accepted that residential waste generation ranges between 2 and 2.5 pounds per person per day, with the remainder being commercial wastes. A typical residential waste generation rate would be 2.2 pounds per person per day.[4]

MSW generation rates vary widely across the country. Rates of over 5 pounds per person per day are reported in states such as New York, while less populous regions have much lower rates. Much of this variation can be attributed to the larger newspapers and the commercial wastes generated by stores, restaurants, factories, etc., in more populous areas.

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[3] U.S. EPA, 1988.

[4] Franklin Associates, Ltd. A Study to Develop a Predictive Technique for the Estimation of Collectible Solid Waste in the United States, for Argonne National Laboratory ANL/CNSV-TM-171, January 1985.

Generation of yard wastes varies widely around the country, with year-round generation in the South (e.g., Florida) and a short growing season in the Northern States. Demographics also affect yard waste generation, with suburban areas discarding more and inner cities less.

f. Volume Versus Weight

The estimates of MSW generation and recovery in this chapter are expressed in terms of weight. Volume is, however, a very important measurement, especially in terms of landfill life. The density of MSW varies widely, depending on the source of the waste and whether it is loose or compacted.

A generally accepted estimate for the weight of MSW in a compactor truck is 600 pounds per cubic yard. The estimate for MSW compacted in a modern landfill is 1,000 to 1,200 pounds per cubic yard. These are estimates only; the variation is large.

B. TRENDS IN MSW GENERATION AND MANAGEMENT

1. TRENDS IN MSW DISCARD

An analysis of information in the EPA MSW database reveals some interesting trends. As Table 1-1 and Figure 1-1 illustrate, gross discards (total generation) of MSW have been growing steadily, as measured by weight. The combined effects of recycling and energy recovery have kept the discards remaining to be disposed of at a fairly constant rate. People actually managing the waste stream, however, perceive that the volume of MSW seems to be increasing, although the increase is difficult to quantify.

Historical data on MSW generation show that paper, plastics, and aluminum have been growing as percentages of the total MSW, while glass and steel--relatively heavy materials--have been declining. From the perspective of products generated, durable goods (appliances, furniture, tires) have remained flat in percentage terms, while nondurable goods have been increasing steadily. Within the nondurables category, newspapers have stayed constant as a percentage of total MSW, but office papers and commercial printing papers have been growing. This increase reflects the growing generation of computer printouts, output from high-speed copiers, and direct mail advertising.

Finally, the containers and packaging category--which many people see as a rapidly-growing source of waste--has actually declined (after a rapid growth in the 1960s) as a percentage of total MSW by weight. Glass and steel containers have been declining in percentage by weight, while aluminum and plastics have been growing by percentage by weight. (Corrugated boxes have also been growing, but after recycling they account for only 8 percent of MSW instead of 12 percent.) Some examples of how things have been changing in packaging and containers are:

- Paperboard cartons and plastic jugs have replaced glass milk bottles.
- Aluminum beverage cans have replaced steel cans.
- Plastic soft drink bottles have, to a large extent, replaced glass bottles in the larger sizes.
- Plastic food jars are beginning to replace glass food jars.
- Plastic grocery bags are replacing paper bags.

There are many good reasons for substituting lighter weight materials in packaging, including safety, lower transportation costs, and ease of handling, but the substitutions may take up the same volume in landfills. Thus, weight could decline while volume remains unchanged. One recent analysis of waste materials in landfills shows the following comparisons of weight and volume by percent: paper 34.5 percent by weight, 45.5 percent by volume; plastic 4.8 percent by weight, 16.3 percent by volume; glass 2.4 percent by weight, 0.9 percent by volume; ferrous metals 4.8 percent by weight, 2.8 percent by volume; aluminum 0.8 percent by weight, 1.1 percent by volume.[*]

With the exception of aluminum beverage cans and polyethylene terephthalate (PET) soft drink bottles, there are few established recycling programs for the newer packages and containers that are replacing the previously used materials cited in the above examples.

2. CONTRASTING TRENDS IN MSW

There are many trends in MSW generation and disposal, and the trends often run counter to each other. For example, generation of MSW is increasing, but at the same time increasing materials and energy recovery have held net discards down to a large extent. Other trends involve the composition, package size, and lifespan of materials.

a. Packaging

Packaging has proliferated, and many packages are composites of different materials, e.g., aseptic boxes made of paper, plastic and foil. Composite materials are often lighter weight than a single material, but on the negative side, they may be difficult or impossible to recycle.

There are conflicting trends in packaging design, also.

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[*] University of Arizona. "The Mullens Dig: An Archeological Excavation of Three Modern Landfills," The Garbage Project, Bureau of Applied Research in Anthropology, University of Arizona, Tuscon, Arizona.

Manufacturers of products may want them in large boxes to take up more display space. Extra packaging may be used to make products tamper-resistant, or to discourage theft. At the same time, package designers have an incentive to minimize waste to save money. For example, the percentage of scrap produced at box converting plants has been decreasing.

b. Durables Versus Nondurables

Another significant trend is the increase of nondurable goods relative to durables. Durable goods include products like appliances and furniture that have long lifetimes before disposal. By contrast, most nondurable goods, such as paper products, are discarded within a year of production. Thus production increases show up in the waste stream almost immediately. However, even durable goods such as furniture and small appliances have construction techniques that are leading to lower average lifetimes than in the past.

3. LONG-TERM TRENDS

Over the long term, the generation of MSW has steadily increased, and so has recycling and energy recovery. Increases in recovery have "flattened" the net discards remaining to be disposed. An examination of the trends as illustrated in Figure 2-1 does show, however, that the future is not always forecast by the past, nor by short-term trends. Projections based on the rapid growth in weight generated in the 1960's would be much higher than those made today. Much of that growth was in steel and glass packaging, which has been replaced by lighter, but not necessarily smaller, packages.

At the same time, declines in MSW generation caused by economic recessions such as in 1975 and 1982 do not mean that production and discards will not return when the economy improves. Orders for goods will be accompanied by orders for boxes and other packaging.

It should be noted that in making projections of MSW components, the status quo situation was the basic assumption. Thus, displacement of print media, for example, by electronic media was not considered; the trends in material use were extended; and the rates of increase of recycling and waste-to-energy were extended. The purpose was to show what would happen given existing trends, not what might be achieved under changes in markets or solid waste management practices.

4. SUMMATION

Municipal solid waste includes wastes from household, institutional, commercial, municipal, and industrial sources. Generation of MSW has been increasing steadily, both in tonnage and pounds per person, and this is projected to continue. At the same time, materials recycling and energy recovery have increased enough to keep discards to be landfilled or otherwise disposed of fairly level in the 1980's.

Although not well documented, the volume of MSW generated is probably increasing faster than the tonnage, because in many cases, lighter materials have been replacing those that are heavier, especially in packaging. Over the long term, nondurable goods have been increasing faster than durable goods, and nondurables enter the waste stream in a much shorter time.

C. COMPONENTS OR PRODUCTS OF CONCERN TO HEALTH OR THE ENVIRONMENT

Although MSW is classified as nonhazardous and is regulated as such under Subtitle D of RCRA, small quantities of hazardous materials are contained in MSW. Some of these are recognized as special constituents in MSW and some are not.

1. SOURCES OF HAZARDOUS CONSTITUENTS IN MSW

Both households generating HHW and business establishments generating less than 100 kilograms (kg) per month of hazardous wastes are sources of hazardous wastes in MSW. In addition to wastes classified as HHW and VSQG wastes, there are hazardous constituents in many wastes that are ordinarily thought of as innocuous.

a. Household Hazardous Wastes

The results of a limited number of studies indicate that HHW's are probably in the range of 0.2 percent to 0.45 percent of total MSW, by weight.[6,7] These wastes include automotive products such as antifreeze and transmission fluid; household products such as bleach and mothballs; painting products such as paint thinner and solvents; repair products such as adhesives and glue; hobby and recreation products such as chemistry sets and photography chemicals; personal care products such as nail polish remover and thermometers; and pesticides and herbicides.

b. Very Small Quantity Generator Wastes

Hazardous wastes from VSQG's are also contained in

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[6] U.S. Environmental Protection Agency, Office of Solid Wste and Emergency Response. Subtitle D Study Phase I Report, EPA/530-SW-86-054, October 1986.

[7] SCS Engineers. Solid Waste Stream Assessment for Macomb, Isabella, Lapeer, Delta, Chippewa, and Marquette Counties, six reports prepared for the Michigan Department of Natural Resources, March 1987.

MSW. However, some states like California require the separation of and separate handling of VSQG wastes. Those business establishments generating below 100 kg per month of hazardous waste, or 1.0 kilogram per month of acutely hazardous waste, may include them with MSW for disposal. The quantity of hazardous wastes from VSQG's is estimated at 0.35 to 0.40 percent of MSW.[a]

Vehicle maintenance establishments generate nearly half of VSQG's. Other significant contributors include the construction industry, metal manufacturing, and other manufacturing. Other nonmanufacturing businesses (in addition to vehicle maintenance) that have significant amounts of VSQG's include:

- Dry cleaners
- Printing/ceramic shops
- Pesticide application services
- Photography establishments
- Analytical and clinical laboratories
- Wholesale and retail establishments
- Educational and vocational establishments
- Other services (e.g., cleaning/maintenance)

Major hazardous waste streams generated by VSQG's are shown in Table 1-6. The dominance of used lead-acid batteries must be attributed to the large number of vehicle maintenance establishments among VSQG's. Well over half the batteries from vehicle maintenance establishments are believed to be recycled. However, the incidence of disposal of batteries in landfills has increased in recent years as some secondary lead smelters have closed.

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[a] EMSL Study.

TABLE 1-6

HAZARDOUS WASTE FROM VSQG's
(<100 kg/month)

Waste Stream	Percent of Gross VSQG Waste Stream Quantities
Used Lead-Acid Batteries	60.5
Spent Solvents	18.1
Dry Cleaning Filtration Residues	4.8
Photographic Wastes*	4.1
Waste Formaldehyde	3.2
Strong Acids or Alkalies	1.8
Ignitable Paint Wastes	1.7
Empty Pesticide Containers	1.2
Pesticide Solutions	1.0
Solutions/Sludges Containing Silver	0.9
Ignitable Wastes	0.8
	98.1

Source: Abt Associates, 1985.

C. Other Sources of Hazardous Constituents

MSW contains many products and materials that have hazardous constituents, but are not ordinarily considered to be hazardous wastes. Some examples include: soldered cans (lead); rechargable cordless appliances (nickel-cadmium); paper printed with inks containing heavy metals; textiles printed with dyes containing heavy metals; grass clippings sprayed with pesticides, etc.

In addition, large household appliances such as refrigerators and washing machines may have capacitors containing PCB's if they were manufactured before 1979. Because there is a long lag between purchase and discard, many of these appliances are now showing up for recycling, or landfilling. They are not regulated under RCRA as hazardous waste. Other old equipment that becomes waste may similarly contain hazardous constituents, e.g., computers, electronic goods, etc.

Other wastes often managed along with MSW may also contain hazardous constituents. Sewage treatment sludges, for example, often contain heavy metals and organic contaminants as well. Municipal waste combustion ash has been found to contain heavy metals, especially lead and cadmium and some toxic organics (e.g., dioxins, dibenzofurans). Demolition wastes may contain leaded paint, asbestos, solder, or other hazardous materials.

Very low level radioactive materials may also appear in MSW. Some potential sources are: water treatment sludges containing radium; smoke detectors and watches; and some waste from hospitals and academic institutions.

2. POTENTIAL HARM TO THE ENVIRONMENT

Hazardous substances in MSW or other wastes managed with MSW may enter the environment through landfill leachate contaminating ground water or surface water, through gases emitted from landfills and incinerators, or in ash from incinerators that is landfilled or become airborne.

Heavy metals that have been found in landfill leachate include cadmium, lead, and mercury. Arsenic, cyanide, sodium, sulfates, etc., have also been found in ground water.[9][10] Priority pollutant organics that have been found in landfill leachate include phenol, toluene, chloroform, vinyl chloride, benzene, and others.[11][12]

Landfill gases have been found to contain benzene, hexane, tetrachloroethylene, toluene, vinyl chloride, and other organics,[13][14] including dioxins.

Municipal waste combustion ash* is currently a major subject of close examination by EPA and the waste-to-energy industry. Both lead and cadmium have been found at significant levels when fly ash and bottom ash samples have been subjected to leaching tests. Lead and cadmium concentrations in fly ash samples are generally higher than levels found in bottom ash samples. Also, dioxins and dibenzofurans have been found in ash.

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[9] U.S. EPA, 1986.

[10] Robinson, W.R., ed. The Solid Waste Handbook: A Practical Guide, John Wiley & Sons, 1986.

[11] U.S. EPA, 1986.

[12] Robinson, W. R.

[13] U.S. EPA, 1986.

[14] Robinson, W. R.

D. PERMANENCE AND DEGRADABILITY

Whether degradability of a manufactured product by any natural process is a desirable feature or not is subject to debate. Landfills are usually designed to slow or to prevent degradation. On the other hand, the rapid degradation of products that are littered could be considered beneficial. The natural degradation process that food waste, grass, and leaves undergo is usually considered desirable. However, the potential presence of toxic constituents, e.g., pesticides and herbicides, may be a consideration when composting is considered. It is unclear, however, that degradation of organic manufactured products is in itself a desirable feature because some of the resultant products can be toxic compounds, e.g., heavy metals, that are potentially undesirable if they are not managed properly.

Municipal solid waste (MSW) is a mixture of about 80 percent organic and 20 percent inorganic materials with a wide range of physical, chemical, and biochemical properties. Some of these materials can be decomposed or degraded, and some are relatively inert.

Whether or not MSW will decompose depends not only on the properties of the MSW components, but also on the environment in which they are placed. Environmental factors are of great importance, influencing the rate and type of decomposition and more significantly, whether decomposition is possible. Some of the more important factors are:

- The amount of water present.
- The presence or absence of oxygen.
- Temperature.
- Chemical characteristics of waste such as its pH.

The nature of the environment in which the solid waste is placed will also affect the type of decomposition that will occur and the end products of the decomposition process.

1. PRODUCTS OF MSW DECOMPOSITION

Decomposition of MSW occurs as the result of microbial metabolism (biodegradation) and by natural chemical processes such as solubilization and oxidation. In the right environment, the organic portions of MSW are consumed by bacteria and other microorganisms. (Moisture is essential to biodegradation, as is the proper temperature range and the absence of certain toxic chemicals.) Early in this biodegradation process, soluble organic waste products are produced by the microorganisms. Typical soluble organics produced during biodegradation include: acetic acid, formic acid, lactic acid, pyruvic acid, and ethanol. These compounds have a disagreeable odor and color and can cause a bad taste when present in water supplies. The soluble organics can then be further degraded by other microorganisms to carbon dioxide and water if oxygen is present, or to methane in the absence of oxygen.

The inorganic portions of MSW can solubilize in a moist, slightly acidic environment. Common metals in MSW that can enter solution include cadmium, iron, lead, copper, zinc, chromium, and aluminum.

2. DEGRADABILITY OF MSW COMPONENTS

The components of MSW that can be subject to microbial biodegradation include:

- Paper
- Yard wastes
- Food wastes

- Wood
- Textiles
- Synthetic rubber
- Leather

Food wastes and yard wastes (primarily grass clippings and leaves) can be almost entirely decomposed to compost by microbial action in a controlled environment that has that objective. Organic acids are produced as intermediate decomposition products. If decomposition goes further, carbon dioxide, water, nitrates, and sulfates will be produced aerobically (in the presence of air), while anaerobically (in the absence of air) methane, ammonia, nitrogen gas, hydrogen sulfide, carbon dioxide, and water will be produced.

Other organic fractions of MSW are less readily decomposed. Wood and some papers (those made with groundwood pulp, e.g., newsprint, rather than chemical pulp) contain lignin, which resists biodegradation. With sufficient moisture, slightly over half of all paper in MSW can be degraded. However, wood has a much lower potential for biodegradation. Textiles are made from a variety of fibers. Synthetic fibers vary in their composition and biodegradability. Organic fibers such as cotton, wool, linen, and silk are readily degraded. Leather is composed primarily of protein, which is completely biodegradable (under both aerobic and anaerobic conditions). Synthetic rubber is resistant to biodegradation, but can slowly decompose in the low pH, slightly warm environment created by anaerobic metabolism of other MSW components.

Plastics are petrochemical products with highly variable compositions and degradability. Most plastics are virtually nondegradable, at least in any reasonable time frame. Photodegradable plastics and corn starch-based plastics, neither of which is a measurable factor in MSW yet, do degrade. Some can gradually decompose in the conditions described for rubber.

The inorganic portions of MSW consist primarily of metals and glass. Glass is an inert compound and is not susceptible to biological or chemical degradation. It will only be affected by physical weathering, causing changes in size and appearance, and a minute amount of leaching of lead and other components from it. Most metals will not degrade biologically, but are subject to oxidation (e.g., rusting) and solubilization. Metals that will slowly solubilize in a pH range of 6 to 8, typical of most surface and ground waters, include: cadmium, iron, lead, copper, zinc, and chromium.

E. RECYCLABILITY OF MUNICIPAL SOLID WASTE

1. THE PRINCIPAL REQUIREMENTS FOR RECYCLABILITY

A high percentage (more than 50 percent) of components in the presently disposed solid waste meet the technical requirements to be recycled. These requirements are that they be separable and processible to a level of quality suitable for recycling applications.

In addition to purely technical (and theoretical) recovery potential, the cost of recovery and processing is an important factor, as is the value of the recyclable material to an organization that utilizes the recovered products as a raw material for a remanufactured product. By the same token, recyclers may assume some unwanted liability because recovered materials or products may contain some unwanted toxic constituents such as lead or cadmium.

With solid waste disposal costs rising today, sometimes dramatically, the concept of cost avoidance has come into play. Thus, if an agency can recover and process recyclables for less than the disposal cost, it is cost effective to do so. Revenue from the sale of recovered materials may play a key role in making this equation work. In other instances, a community may recover and process materials because "it is the right thing to do" to conserve natural resources and/or to enhance environmental protection.

Some products in municipal solid waste are not recyclable at present levels of technology and costs. Examples include:

- Wastes heavily contaminated by food residues, household chemicals, or dirt.
- Infectious wastes.
- Composite materials, e.g., aseptic boxes (paper, plastics, foil, and adhesives), plastic-coated paper, furniture and appliances (other than their metal content)
- Miscellaneous inorganics like street sweepings.

2. RECYCLABLE COMPONENTS

The principal recyclable components of MSW that are readily identifiable are:

Materials:

- Paper--newspapers, corrugated boxes, office papers, mixed papers
- Plastics--PET soft drink containers, high-density polyethylene (HDPE) milk bottles, other HDPE containers
- Glass--bottles and jars
- Aluminum--cans and other aluminum products
- Steel--cans and other steel products
- Wood--pallets, lumber, etc.

Compost

- Leaves, grass and brush
- Food wastes
- Some other organic materials, such as paper contaminated with food

Residues

- Incinerator ash and other organics

Using the above recyclable components, a theoretical level of useful recovery can be determined assuming the very unlikely event of total recovery of currently recyclable or compostable materials. The following are derived from the above list and Franklin Associates, Ltd., 1988:

Paper	20.8 percent
Plastics	2.0 percent
Glass	7.6 percent
Aluminum	0.5 percent
Steel	3.6 percent
Wood	1.5 percent
Subtotal	36.0 percent
Food and Yard	29.0 percent
Total	65.0 percent

Similar values have been developed for specific areas contemplating extensive recovery programs. When the constraints of practical and economic considerations are imposed, however, the values drop to half or less.

3. SUMMATION

In all, over 50 percent of the presently-disposed MSW could technically be recovered, collected, and processed to a useful level. The economics and market potential are largely untested with respect to this level of intense recovery. Finally, materials or products are not likely to be inventoried if there is not a market or recycling technology in place.

F. COMBUSTIBILITY OF MUNICIPAL SOLID WASTE

1. INCINERATION OF MSW--VOLUME REDUCTION AND ENERGY RECOVERY

Incineration of MSW will result in reduced landfill volume and generation of useful energy products. Typically, MSW will have a noncombustible fraction ranging between 20 to 25 percent, by weight, depending on the type of incineration unit. Thus, complete combustion of MSW may be expected to effect a quantity reduction of 75 to 80 percent, by weight. A greater reduction in landfill volume would be achieved, however, because noncombustible materials represent only 10 to 15 percent by volume of the original MSW. An 85- to 90-percent reduction by volume is typical.

Because it is not homogeneous, MSW burned for heat recovery is a less efficient fuel than fossil fuels, and the recovery of available heat energy is usually lower than for fossil fuels. Mass burning of MSW may typically be expected to result in energy recovery efficiencies ranging from 50 to 70 percent compared with 75 to 80 percent or higher with fossil fuels.

2. HEAT CONTENT OF MSW

Higher heating values (HHV's) determined for MSW net discards are shown in Table 1-7. The Btu values calculated assume a national average waste composition for net discards. An HHV is shown for each MSW component as well as for total MSW. These values shown in Table 1-7 are for the MSW components in the "as generated" condition. These values were expressed in the as generated condition because the migration of water from food and yard wastes causes other organics, especially paper, to show a lower Btu content when the wastes are mixed.

The HHV of "average" (or mixed) MSW is shown in Table 1-7 at nearly 5,400 Btu per pound. This is a higher value than those often quoted in the literature and is probably attributable in large part to the increasing percentages of organics in MSW, especially paper and plastics. The organics fraction has increased from an estimated 75.5 percent of total MSW in 1975 to 80.8 percent in 1986. Plastic and paper wastes both increased several percentage points during that time and both are high Btu-value wastes. Thus, the Btu value of MSW has increased even more than the proportionate increase in organics.

A review of the HHV's shown in Table 1-7 illustrates the wide variations in energy values among the organic compounds in MSW. Whereas plastics are shown at nearly 16,000 Btu per pound (some plastics are 18,000 Btu per pound), food wastes and yard wastes are both under 3,000 Btu per pound. Paper grades range between 7,000 and 8,000 Btu per pound depending upon the paper grade. Paper wastes account for nearly 36 percent of MSW (after recycling) and nearly half of the total HHV.

TABLE 1-7

MSW NET DISCARDS* COMPOSITION AND ENERGY VALUES, 1986

MSW Component	Net Discards Percent by Weight	Higher Heating Value (Btu/lb)	Percent of Total MSW HHV
Paper and Paperboard	35.6	7,357	48.7
Inorganics (Glass, Metals, Miscellaneous)	19.2	0	0
Plastics	7.3	15,982	21.6
Rubber and Leather	2.8	10,769	5.6
Textiles	2.0	8,685	3.2
Wood	4.1	7,328	5.6
Food Wastes	8.9	2,840	4.7
Yard Wastes	20.1	2,876	10.7
Total	100.0	5,392	100.0

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* Net discards (as generated) after materials recovery and before energy recovery.

Source: Franklin Associates, Ltd., 1988 (columns 1 and 3), and Ralph M. Parsons Co., 1977 (column 2).

3. SEASONAL VARIATIONS IN COMBUSTIBILITY

Seasonal changes in MSW quantity and composition are attributable in large part to yard wastes. Grass clippings are a high percentage of MSW in the spring and leaves are a high percentage in the fall. Yard wastes account for approximately 20 percent of MSW net discards on the average, but this percentage may more than double during certain times of the year. Because of the high moisture in yard wastes, the HHV is low and increased quantities of yard wastes reduced the HHV of MSW in Btu's per pound. Conversely, when yard waste quantities are low (during winter), the per pound energy value of MSW increases.

Removal of yard wastes from MSW through composting or other methods may have a beneficial effect on MSW incineration. Little energy value is lost, and the combustibility of the remaining MSW is better because of reduced moisture and higher energy per pound. Also, yard waste removal tends to reduce seasonal fluctuations in both quantity and Btu content, which in turn reduces the need for additional incineration capacity to handle seasonal peaks.

Removal of inorganic recyclables (i.e., glass and metals) from MSW also improves the combustibility of the remaining waste. No heat energy is lost, and the inorganics removed are no longer absorbing heat from the organic materials in the combustion process. All inorganic materials removed from MSW improve HHV per pound of the MSW remaining.

Removal of paper or plastic wastes for recycling lowers the total Btu value of the MSW, leaving the remaining MSW with a lower heat value. If paper and/or plastics are the only materials removed, then the heating value per pound would also be lowered. Since paper and plastics have low moisture content, the MSW remaining will also have a higher percentage moisture content as well.

At the levels of recovery that might be achieved, however, there is very little reduction in Btu value per pound of MSW, even though there might be significant removal of some combustible components like newspapers, corrugated boxes, and PET soft drink containers. For example, if half the newspapers and half of the corrugated boxes are removed from net discards of MSW, the result is a drop of only 3 percent in the Btu per pound of the remaining MSW. Because it would be unusual for only the high Btu content materials to be removed for recycling, it is likely that the Btu content per pound would be higher if aluminum, glass, steel, and/or yard wastes were removed for recycling or composting.

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CHAPTER 2

SUMMARY OF CURRENT WASTE MANAGEMENT PRACTICES

A. SOURCE REDUCTION

1. WHAT IS SOURCE REDUCTION?

Source reduction is the design, manufacture, and use of products so as to reduce the quantity and toxicity of waste produced when the products reach the end of their useful lives. Source reduction is not a technology or process (such as landfill, incineration, recycling, or composting), to be applied to the solid waste stream. In applying the concept of source reduction, one fully considers the ultimate destiny of products when making decisions on how the products are made and which products or materials one uses. The objectives of source reduction measures are:

- To reduce the toxicity of solid waste generated; and
- To reduce the quantity of solid waste generated.

Source reduction activities can occur throughout most of the life cycle (design, manufacture, purchase, use) of a product, container, or package and would involve changes in the way products are made and changes in product consumption. The purpose of this chapter is to describe source reduction measures which are currently being employed.

A source reduction ethic is not dominant in today's production or consumption habits. Neither manufacturers nor consumers seem to give serious consideration to waste generation and to the ultimate destiny of the items they make or consume. Rather, production and consumption trends have been leaning toward increasing volumes, and more single-use, nonrepairable and nonrecyclable products, containers and packaging.

Traditionally, municipal solid waste management has relied mostly on technologies which handle waste after it has been generated. Awareness and acceptance is now increasing for the integrated waste management (IWM) approach involving a combination of source reduction, composting, recycling, waste-to-energy, and landfill. While the other elements of integrated waste management have been aggressively pursued, implementation of source reduction measures has been minimal. Recently, however, attention has turned to source reduction measures to reduce waste generation.

It has likely been a combination of factors that have stymied movement of source reduction from policy into action. Traditional solid waste management practices really only impacted persons involved in collection and landfilling of the wastes--product manufacturers and consumers had little involvement and bore little responsibility. Source reduction measures, however, could affect all products manufactured, involve changes in design and manufacturing practices, and impact the "throwaway" convenience most Americans have come to expect. In addition, source reduction measures have been slow to gain significant support because the results are not readily visible. For example, it is easier to see the effect of a recycling program processing materials back into products than it is to see the impact of source reduction measures which are preventive (resulting in things not happening and not being generated) and may be long term in nature.

The merits of "an ounce of prevention" seem to have influenced the direction of hazardous waste management and other areas of high health-related risks. Although source reduction of solid waste is not a new concept, the "throw-away, out-of-sight, out-of-mind" mentality and perception of solid waste as nonproblematic have dominated. Only recently has there been real interest in the preventive benefits of solid waste source reduction.

Currently, with solid waste issues in the news, depletion of needed landfill capacity, difficulties in siting landfills and incinerators, and soaring disposal costs, source reduction of solid waste has begun to receive serious consideration. Local and State governments are interested in the possibility that source reduction might abate waste management costs and environmental risk, avoid liability costs, preserve landfill capacity, and conserve natural resources.

Some States and local governments have tried to stimulate source reduction activities through education or through legislative incentives (tax credits/exemptions) or disincentives (bans, taxes).

2. WHO'S INVOLVED

a. Manufacturers

Manufacturers and consumers of goods form a symbiotic relationship in today's market economy in the United States. The role of manufacturer or consumer as cause or effect in product development is thus a debatable point. However, only the producer can change the product, container or package design. Moreover, manufacturers act in the dual role of consumers (procurers) and producers (manufacturers) of goods as they obtain raw materials and equipment for use in their production lines. Manufacturers design, produce, and advertise products that are responsive to the demand choices of consumers. Market demand influences design choices of manufacturers. However, manufacturers also exercise choices and can influence market demand.

In designing and producing goods, manufacturers should consider the fact that once their product, container or package has served its useful purpose, it must be handled as solid waste in some way (i.e., composted, recycled, incinerated, or landfilled). The source reduction ethic would direct manufacturers to "design for source reduction"--that is, for reduced toxicity and quantity of waste and increased useful life of products.

b. Consumers

In selecting among goods, consumers choose on the basis of design and function and on the basis of past experience or perceived differences created through advertising. Elements contributing to consumers' choices include:

- Quality of product in performing a desired function.
- Convenience.
- Effectiveness of packaging (against spoiling, tampering, etc.).
- Attractiveness of product and packaging.
- Price.
- Potential for reuse and the nature of waste generated when the product no longer serves in its intended use.

There is little evidence that the last of these elements is a significant factor in dictating consumer buying habits, except for a minority of environmentally aware consumers. Manufacturers respond to consumer demands for convenience, attractiveness, quality, and price--factors that significantly influence sales. Nonetheless, heightened awareness on the part of both manufacturers and consumers about the destiny of what they produce or purchase could lead to a shift in the motivations of each party.

3. SOURCE REDUCTION IN PRACTICE

a. In the Past

The Resource Conservation and Recovery Act of 1976 established the Resource Conservation Committee. In its July 1979 final report, "Choices for Conservation," the Committee addressed source reduction issues. The Committee identified three approaches to achieving source reduction: product regulations, financial incentives and financial disincentives.

The Committee also studied ten policy areas in the larger context of waste reduction:[1]

(1) Existing federal tax subsidies for virgin materials.
(2) Extraction taxes on virgin materials.
(3) Subsidies for resource recovery.
(4) Railroad freight rate discrimination.
(5) Product regulation.
(6) Beverage container deposits.
(7) Deposits and bounties on durable and hazardous goods.
(8) National litter tax.
(9) Local user fees.
(10) National solid waste disposal charge.

The Committee's only area of agreement was the unanimous endorsement of local user fees (variable fees that change according to the amount of waste put out for collection). It supported further study of this option and of the barriers to its implementation, but no subsequent actions came as a result of this recommendation.

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[1] Resource Conservation Committee, "Choices for Conservation," July 1979.

There have been recent changes in design and production that would fit under the category of source reduction. Specific source reduction actions have resulted in the following changes:[2]

Decreased toxicity. The use of mercury in dry cell batteries has decreased by 65% since 1984.

Increased useful life. Advances in tire design have increased the average useful life span of car tires, and advances in dry cell batteries have increased their useful life by 45% since 1983.

Decreased materials use. Advances in resin technology have led to manufacture of plastic bags and plastic milk jugs with less material than was needed in earlier designs.

Changes in production processes (in-house reuse). In the manufacturing process many materials once discarded (such as trimmings) are being placed back in the production process.

Redesign resulting in less waste generation. The advent of duplex copiers (copiers which use two sides of paper) has made it possible to decrease the amount of paper used; and

Packaging trends. Advances in plastic resins have enabled plastics to replace other heavier and bulkier materials (such as shrink wrap replacing wood crates).

Significantly, the changes mentioned above did not, for the most part, stem from efforts to foster source reduction objectives. Rather, they occurred to decrease production costs and increase sales. Manufacturers have little incentive to be concerned with the destiny of their products because they bear neither the responsibility nor the cost of handling the wastes that their products ultimately become.

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[2] "Design for Disposal Policy Dialogue," remarks made at the Conservation Foundation, June 14, 1988.

There are examples of past State and local educational and legislative actions aimed at advancing the objectives of source reduction. In-store consumer education campaigns have promoted source reduction values such as long life, reusability, etc. through labelling and posters.

With respect to legislation, there have been many attempts to ban or tax products or materials that were considered undesirable. Proposed bans have been directed toward specific materials (such as PVC plastics), product groups (such as disposable diapers), and containers or packages (such as plastic beverage containers and fast food packaging). Such proposals have most often not been adopted. The few that did become law were legally challenged and either found unconstitutional or became entangled in costly and lengthy litigation.

One of the only bans to have succeeded in several States requires that plastic six-pack rings be made of photodegradable plastic. The success of such regulations can most likely be attributed to the visible negative impact of the item in terms of litter, the potential danger it posed to wildlife, and the fact that there was an available substitute.

A unique case with respect to bans is the Minnesota Packaging Law of 1973. The Minnesota Legislature gave a State agency the authority to prohibit the introduction of new or revised packaging on the grounds (among others) that it constituted a solid waste disposal problem. Challenges to the law and the asociated regulations delayed implementation. In the end the Minnesota Supreme Court endorsed the validity of packaging review regulations. However, lacking express authority by the State legislature, the regulations were without force and effect of law--in other words, they were purely advisory. The law remains on the books but it has not been, and likely never will be tested.

As reviewed above, there are examples of measures by government and industry that have advanced source reduction goals. However, there have also been changes in product design and consumption habits that run contour to source reduction objectives. Packaging and product trends have continued to shift significantly toward increased consumer convenience and time savings. These trends are related to consumer lifestyle changes and marketing techniques.

Examples of products designed to increase consumer convenience (and consequently increase waste) abound: disposable diapers, disposable razors, disposable cigarette lighters, even disposable telephones, and an increase in fast food packaging and single-serving items (frozen dinners for one). Widespread acceptance of these designs that increase waste quantities (i.e., product disposability) point up the lack of awareness on the part of consumers and an undervaluing of the waste issue as part of their purchasing choices. Increased use of packaging has also occurred for other reasons, such as to protect items from tampering (security seals) or to discourage shop lifting (blister packaging).

b. Currently

In the past two years, attempts to promote source reduction objectives through legislation have increased significantly. Because these State measures are so new, their efficiency in reducing the toxic constituents and quantity of solid waste is unknown. The following are some examples of recent measures:

Rhode Island[3]

1) In November 1987, a statewide Source Reduction Task Force outlined a State source reduction program which was incorporated into the States's comprehensive solid waste management plan.

2) In 1987, the statewide Task Force introduced successful bills to make source reduction the top priority in solid waste management planning, and to authorize the Department of Environmental Management to develop a logo for use in identifying items with source reduction qualities.

3) In 1988, the Task Force introduced a package of bills. Included were a ban on multi-resin plastic containers (because they are difficult to recycle); a tax on hard-to-dispose-of items; a bill promoting the use of paper bags; a ban on nonbiodegradable tampon applicators; a ban on the plastic beverage can; and a requirement that prepared foods be sold in packaging that is recyclable, biodegradable, contains recycled materials, and is not made with CFC's. Two bills were to be adopted in this session: 1) the bill promoting the use of paper bags (exempting them from the State use tax and requiring that stores have paper bags available) and 2) a bill taxing businesses that sell a significant amount of litter-generating items.

4) In 1988, meetings were held with product and packaging manufacturers and preparations have begun for an in-store consumer education campaign. The State also

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[3] Gold, Marion, Rhode Island Source Reduction Task Force. Personal communication, June 23, 1988.

plans to provide technical assistance to businesses through waste reduction and recycling audits that will suggest internal production changes to achieve source reduction and recycling goals.

New Jersey[4]

Several bills have been introduced and are pending: the Solid Waste Reduction Act of 1988 proposes a 2-cent tax on certain nondegradable or nonrefillable packaging/containers. Two other proposed bills (S.126 and S.127) would ban or tax certain plastic packaging and disposable plastic products. Other pending legislation includes a ban on plastic tampon applicators (S.1542); a ban on polystyrene packaging (A.115 and A.2038); and a ban on government purchase of polystyrene products.

New York[5]

A proposed bill would place a 3-cent tax on packaging and ban polyvinyl chloride and polystyrene fast-food packaging unless it is recyclable, reusable, or made of recycled materials.

In Suffolk County, a local ordinance bans the use of plastic grocery bags and other plastic food containers, starting in July 1989. The law prohibits the use of polystyrene foam and polyvinyl chloride for food packaging in bars, restaurants, delis, roadside stands, grocery stores and other retail food establishments.

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[4] The Returnable Times, newsletter of the Environmental Action Foundation, Washington, D.C., April 1988.

[5] The Returnable Times.

Minnesota and Connecticut[6]

Both states have banned the plastic beverage can. In Minnesota, a blue ribbon panel will be reconvened to encourage waste reduction, expand recycling and reduce the toxicity of the waste stream.

Florida

The State recently enacted legislation including measures for "... reduction of the solid waste stream." One measure provides for an "advance disposal fee" of one cent per container to be applied to various types of containers which are not recycled at a sustained rate of 50% as of October 1, 1992. The statute also provides for a "product waste disposal fee" which would be imposed on producers or publishers consuming newsprint. The fee of 10 cents per ton of newsprint consumed could be offset by a per-ton credit for newsprint returned for recycling.

Massachusetts[7]

Several source reduction measures have been proposed: a packaging tax of 3 cents (2 cents if the packaging is made of recycled materials and 1 cent if it is recyclable); establishment of a packaging review board; a bill requiring plastic containers to be made of a single resin; and tax investment credits for the private sector.

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[6] The Returnable Times.

[7] Schall, John. Personal telephone conversation, July 5, 1988.

Other Activities

In addition to increased legislation in this area, there are signs of increasing consumer awareness about purchasing habits and subsequent impacts on solid waste generation and management. One example is the response to the Food and Drug Administration plan to approve the use of PVC plastic for food contact packaging without requiring an Environmental Impact Statement. Significant public opposition was voiced, the approval was delayed, and the decision is pending with respect to requiring an EIS.

With the obvious increase in consumer awareness and legislative actions relating to solid waste generation and disposal, manufacturers have given greater consideration to the destiny of the products and packages they manufacture. Manufacturer representatives are attending forums and meetings held by State offices or public interest groups on issues of waste generation. Several manufacturers have formed groups within their companies and trade associations to address concerns over their products and related disposal impacts.

Chapter 2

SUMMARY OF CURRENT WASTE MANAGEMENT PRACTICES

B. RECYCLING

Background

In the context of solid waste management practices, the role of recycling is to remove materials from the municipal solid waste stream and to reroute them through the manufacturing system into new products. This role is accomplished via a five-step process that involves: collection, separation (before and/or after collection), processing, marketing, and utilization in remanufacture.

Recycling is not new by any stretch of the imagination. As an adjunct to solid waste management, recycling goes back decades; as a private industry, recycling is as much a part of the industrial infrastructure as virgin raw materials are.

From a historical perspective, recycling grew along with and as an integral part of the industrialization of America. In the early days the recyclables were rages, fat, bones, "tin", and the like. With manufacturing came the recycling of paper, ferrous metals, nonferrous metals, glass, wood, plastics, and other materials.

The latter list is the one familiar to most people today. Recycling has gone through some major cycles in this century both as a private industry and in its direct linkage to the solid waste management system.

During wartime, particularly World War II, the demand for resources exceeded their supply, leading to large-scale efforts to reclaim materials being discarded into the solid waste stream. There was widespread recovery of paper, steel cans, food wastes manufacturing industries were heavily dependent on scrap or secondary materials.

After WWII, the basic industries such as paper expanded rapidly, tapping the vast virgin materials resources available. Recycling, while still very important, did not share in the growth and the tie to solid waste systems went into deep decline. The secondary materials industries focused on "clean" industrial sources of scrap while expanding efforts on some postconsumer sources such as automobile hulks and certain paper and paperboard grades from commercial and household sources, e.g., old newspapers and corrugated boxes.

When the environmental movement was born in the early 1970s, there was a resurgence of interest in recycling and a number of community-based programs sprang up along with a limited number of curbside collection programs. A number of community-based programs were established by non-profit groups and environmental groups at this time.

At the same time, there was a reversal of previously declining recycling rates and a slow but steady increase in the recovery of postconsumer* materials such as newspapers, corrugated boxes, aluminum cans, and glass containers.

Once again, however, the private sector and market-driven activities of the secondary materials industries were predominant, with little effect from materials recovered in community-based programs. Volunteer and nonprofit groups began recovery and collection programs, motivated by the environmental movement and the ethic to conserve resources. Many of these programs soon disappeared because of adverse economics and departure of key operators. Some fortunate ones found strong enough community financial support to continue.

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* "Postconsumer" is by definition the products and materials that have served their useful purpose and are discarded. Most MSW is postconsumer solid waste including that coming from industrial, commercial, and institutional sources, as well as from residential sources.

However, from the mid-1970s up until 1986, there was little activity beyond the private sector providing the supply of recyclable materials. Since that time, municipalities, private waste haulers, and newly-formed private profit and nonprofit businesses have more actively pursued recovery and collection programs as landfill capacity has come under increased pressure and new waste-to-energy projects have had the requirements for recycling programs placed on them.

Thus, the thrust to directly involve the solid waste management system has been vigorously rejuvenated. As will be discussed later, however, the traditional secondary materials industries are still very much the dominant factor. It is, however, the postconsumer waste that now becomes into focus, as from residential sources, whether recovered by private sector systems or fed into the same system from community-based programs.

Present Recycling Practices and the Relationship to Postconsumer Wastes

Postconsumer materials currently recovered for their value as recyclable materials include: newspapers, corrugated boxes, office papers, mixed papers; ferrous metals from white goods, cans, and the like; glass containers; aluminum cans; PET (plastic) soft drink containers; and lead-acid automobile batteries. Limited efforts are being made on other plastics, automobile tires, used oil, other batteries, and wood. Sources of these include households, commercial and institutional organizations, and municipal solid waste (Table 2.B-1).

Table 2.B-1

SOURCES AND USES OF RECYCLABLE MATERIALS

Recyclable Material	Sources	Uses
Paper*		
Newspapers	Consumer	Newsprint, paperboard, insulation, construction
Corrugated	Industrial/commercial	Linerboard, medium, paperboard
High-grade paper	Commercial	Tissue, printing, paperboard
Mixed paper	Commercial	Construction grades, paperboard
Glass Containers		
Glass bottles	Consumer	Glass containers, insulation, reflective material
Ferrous Metal*		
Tin cans	Consumer	Detinned scrap, structural products
White goods	Commercial	Structural products
Nonferrous Metals		
Aluminum cans	Consumer	Can sheet, castings
Other aluminum	Commercial	Aluminum castings
Lead-acid batteries	Commercial	Lead products, batteries
Copper	Commercial	Copper products
Plastics		
PET	Consumer/commercial	Fiberfill, auto parts, strapping
HDPE	Consumer/commercial	Geo-textiles, flower pots

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* Substantial export activity also.

Source: Franklin Associates, Ltd.

The industrial and commercial sectors provide most of the tonnage of materials recycled, as may be seen in Table 2.B-2. Most scrap is generated in the manufacturing and converting processes, then is recovered for use on-site or is sold to other users. It is important to note the classifications in Table 2.B-2. In this context, postconsumer is meant to designate those recovered materials that would otherwise be in MSW.

The principal purpose of Table 2.B-2 is to show what percentage and tonnage of materials are derived from postconsumer solid waste, which is unrecovered would be in MSW and disposed. This demonstrates the level of dependence of the recycling industries on those sources of materials. The table does not indicate, however, the dependence on community-based programs. Some comments on each show how they differ from each other.

Paper. About two-thirds of recovered paper and paperboard is postconsumer products such as corrugated boxes, newspapers, computer printout, etc. A total of 14.6 million tons of postconsumer paper was recovered for recycling in 1986. A growing amount, especially newspapers and some office papers, is being derived from community-based programs. Much of any expansion that takes place in paper recovery will be dependent on a direct or indirect tie-in to MSW recovery programs, such as curbside collection of recyclables. Fifty million tons of paper are still disposed in landfills and incinerators.

Glass. Glass recovery is a phenomenon of MSW management, being tied directly to mandatory beverage container deposit laws, voluntary consumer activity, and various public and private collection programs and centers. The recovery was about 1.1 million tons in 1986 (Table 2.B-2); this left 10.6 million tons disposed of in solid waste management systems.

Table 2.8-2

RECOVERY OF MATERIALS FOR RECYCLING, 1986
(In million short tons and percent)

Category of Recycled Material	Total Recovery	Industrial/Converting Scrap	Post-Consumer Scrap	Percent Post-Consumer	Unrecovered in MSW
Paper and Paperboard	22.3	7.7	14.6	66	50.1
Glass (containers)	1.1	---	1.1	100	11.8
Metals:					
Ferrous metals	49.4	49.0	0.4	1	10.6
Aluminum	2.7	2.1	0.6	22	1.7
Other non-ferrous	3.7	3.7	Neg.	0	0.3
Plastics	NA	NA	0.1	NA	10.3
Rubber	NA	NA	0.1		3.9
Totals			17.0		88.7

NA = not available

Source: Franklin Associates, Ltd.; Institute of Scrap Recycling Industries, Inc.

Some recovery takes place from commercial operations such as food packers and beverage bottlers, but the greatest recovery is from postconsumer sources. Thus, increased recovery is dependent on individual consumers and businesses to make the initial separation and cleaning.

Aluminum. The same can be said for aluminum beverage cans. However, there is also more extensive recovery of aluminum scrap (78 percent) that is derived from industrial plants and other commercial sources not directly related to MSW. The two recovery efforts operate almost independently--aluminum cans as described for glass above and other aluminum scrap within the traditional secondary materials industries. As shown in Table 2.B-2, the recovery of aluminum (cans) is 0.6 million tons, or 22 percent of total aluminum scrap. There is an estimated 1.7 million tons unrecovered in MSW, most of which is aluminum products other than beverage cans.

Ferrous Metals. Ferrous metals are interesting because the recovery from MSW sources is very low compared to the total recovery from other industrial and converting sources. Also, when demand expands, the secondary materials industry can seek sources of scrap in the form of abandoned bridges, machines, auto hulks, buildings, and the like rather than seek out MSW sources. Thus, the one percent postconsumer recovery is likely to remain quite low. (Obsolete scrap*, which is a term applied to the trade that is also postconsumer, is derived principally from industrial and commercial sources that normally do not enter MSW). Only an estimated 0.4 million tons of ferrous scrap were derived from MSW sources in 1986, compared to 49 million tons of other sources of prompt and obsolete scrap.

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* Obsolete scrap is a scrap metals industry term used to identify scrap that is derived from postconsumer sources, but is recovered by businesses such as plumbing contractors, construction and demolition trades, and the like.

Plastics. Plastics are just beginning to be recovered as postconsumer scrap in the form of PET bottles, milk bottles, and mixed plastics. An unknown but much larger quantity is derived from plastics product manufacturers and from resin makers. In a sense, plastics recovery is about where aluminum can recovery was in the early 1970's or paper recovery was 50 years ago. Momentum is building in plastics recovery.

Other Materials. Finally, rubber in the form of tires is recovered in small quantities, but the retreading business is active only in truck and airplane tires. Most rubber recovery is a waste-to-energy application and is, therefore, not recycled by definition. There is a vast store-house of tires in "tire dumps" and other storage situations.

Textile recovery is minimal today because of the predominance of synthetic fibers. However, there is an active secondary material trade in cotton, wool, and some synthetics.

Summary. Thus, the table shows that postconsumer waste and recovery from MSW is very important for paper, glass containers, and aluminum cans. These are recovered from what would otherwise be MSW disposed of in landfills and incinerators. By contrast, plastics and rubber tires are sources of potential growth in recovery from MSW from very low levels today. Ferrous metals and nonferrous metals (except aluminum cans) are in a unique situation of well developed secondary materials infrastructure with little dependence on materials recoverable from MSW.

The quantities of postconsumer waste recovered from community-based programs are still almost insignificant in comparison to total recovery. However, in some locations--e.g., New Jersey with its mandatory recycling* law--the supplies of recovered materials from community-based programs are building rapidly.

Overall, 10.8 percent of postconsumer materials derived from MSW was recovered for recycling in 1986. This represents 17.0 million tons as shown in Table 2.B-2--an overwhelming part of which is paper. There are insufficient data to identify that quantity derived from community-based programs, but a "ball park" estimate is 5 percent ± in 1986.

Collection and Separation Methods

The process of recycling involves the collection and separation of materials. Usually separation comes first, then collection. Separation is usually done by the generators--i.e., citizens, businesses, industries, or institutions. Then, they are delivered or picked up for delivery to a materials processing center or to a scrap processor such as a metals processor or waste paper packer. In some instances, mixed materials are first collected, then separated. The collection and separation steps differ by system and by type of material, with the dominant factor the private sector. For purposes of illustration, four categories of collection/separation systems are summarized. They are: secondary materials industries; beverage container recovery systems; community-based systems; and mechanical processing systems.

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* Recycling is something of a misnomer. What is usually the case is that collection and separation take place. Then the recovered materials move into the private sector for processing, marketing, and utilization. Recycling is the completion of all five steps.

Secondary Materials Industries. At present scrap metals and waste paper are the dominant traditional private sector industries. For the collection and separation steps, the following are the common techniques. (Refer to Table 2.B-2 to note the dominance of metals and paper recovery from a tonnage standpoint; most of this tonnage moves out of the traditional private sector scrap industries.)

From industrial, converter, and retailer sources, paper and metals are usually segregated by the generator and then either baled or collected in rolloff containers. Typically they are picked up by the scrap dealer/processor for preparation. Some generators may move segregated materials to central points before turning them over to scrap processors, e.g., old corrugated boxes may be hauled from supermarkets to a central food warehouse, where they are then baled. There is an economic incentive to segregate clean and uniform scrap, since the scrap dealer system rewards the generator based on market conditions. Waste paper is either converter scrap such as trimmings and printed waste, or postconsumer such as computer printout or corrugated boxes. Metals are usually derived from fabricators, machine shops, and the like who produce "prompt" scrap.*

Individuals also segregate and collect scrap paper and metals. Typically they segregate newspapers in the home and perhaps aluminum cans. These are then either collected by a nonprofit group for delivery to a rolloff or dealer site or delivered by individuals to those locations. "Paper drives" are nearly as old as recycling and still an active collection technique.

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* Prompt scrap is that scrap metal derived from the fabrication of metal products from generic metal products such as sheet, rods, and bars.

Metals from postconsumer sources are referred to as obsolete scrap and are often collected and delivered to a scrap yard by a scavenger or a business such as a plumbing or electrical contractor. Some metals like aluminum cans are handled in much the same way as newspapers.

The notable aspects of collection and separation steps are low cost and convenience for the industrial, commercial, retail generator. For the individual recovery systems, the most significant aspect is voluntary labor, collection by private auto or truck and minimal economic reward.

Beverage Container Recovery Systems. Activity at the state level to promote beverage container deposit laws in the 1970s led to two types of recovery systems for beverage containers. One is a response to promote voluntary citizen recovery of beverage containers. BIRP (for Beverage Industry Recycling Program) is typical. The beverage industries in a nondeposit state sponsor a BIRP program. By organized effort and promotion, citizens are urged to deliver aluminum cans, glass bottles, steel cans, and PET containers to a buy-back center. The materials are prepared for market and sold to end users or to scrap dealers. Citizens, civic groups, and charitable organizations receive payment for collection of the beverage containers. (Some may also take newspapers and other materials.)

A method employed to force recycling is mandatory beverage container deposit laws at the state level. Historically, this type of legislation was generally designed as a litter control measure; however, it is increasingly being recognized that public awareness of and participation in recycling is also enhanced. The laws require a deposit on beverage containers at the point of purchase; empty bottles and cans are returned by the purchaser to retail outlets, where the deposit is redeemed. This approach makes the retail and wholesale distribution system responsible for processing and marketing the recyclable materials. In several deposit states the retailers contract with specialized firms to process and market the material collected in materials recovery facilities. Collection is accomplished by the retail sector.

Beverage container deposit laws are a strong economic incentive to citizens, and typically 85 to 90 percent return rates are experienced. The affected industries have strongly resisted deposit laws, but they are in place in eight states.

California has a law requiring collection centers and an economic incentive of one cent per container to return containers for recycling.

Community-Based Programs. Community-based programs are being put in place rapidly, especially in the Northwest and on the West Coast. Others have been in place for years, and there are community-based programs in almost all geographic sectors. While they almost always are referred to as recycling programs, in fact most are materials collection programs that do not process extensively or market materials.

Source separation at the home and the use of drop-off centers and/or buy-back centers is common. Also, curbside collection programs are common. Usually the collection function is performed by a municipality using its own crews or by private waste haulers under contract. Drop-off and buy-back centers are usually operated by nonprofit or profit-oriented private firms, including waste haulers.

In addition to those programs tied to household sources, there are private haulers who sort and bale corrugated boxes collected from commercial routes at transfer stations. Also, some private haulers have initiated collection programs for other materials at commercial accounts. Some have their own processing and baling capability.

There is some overlap developing between private haulers and municipalities and the secondary materials industries. For example, some metals processors and waste paper dealers provide containers at transfer stations, landfills, and processing centers.

A common form of collection for households is drop-off centers and/or buy-back centers. Thousands of these exist throughout the United States. Community members perform the collection and aggregation function by bringing their recyclable materials to specified areas where materials can be sorted and shipped in bulk. These may be permanent sites or periodic pickup areas such as temporary containers in shopping center parking lots. Delivered materials may be separated or commingled; however, most accept only separated material. In this case, the householder adds value by providing the first transportation link and separation from mixed waste. Commingled materials require some processing of materials by staff or volunteers on-site. Another form of drop-off facility is buy-back centers where cash is exchanged for a recyclable material. Aluminum, by far the most valuable commodity, often provides the bulk of the cash flow to fund the facility.

Curbside collection of recyclables increases the cost of collection programs; also, it increases the participation in the program and the quantities of materials collected. Trucks and laborers go out on collection routes and pick up the community recyclable materials at the curbside in a manner similar to traditional trash collection. In some circumstances, this is done in conjunction with the municipal waste collection; however, it is generally a separate collection using specialized trucks. Scheduled weekly collection results in higher participation and materials at commercial accounts. Some have their own processing and baling capability.

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Materials can be put out by individuals either sorted or commingled. If commingled, some programs have separation done manually at the curbside by the collection crew. Other programs provide processing facilities that sort the materials by type.

Mechanical Processing. Materials can be separated from the mixed MSW stream for recycling at facilities that process waste, sometimes referred to as front-end processing facilities. These plants, in addition to separation, cleanup, and aggregation of recovered materials, also produce refuse-derived fuel (RDF) and/or MSW compost. The processing lines employ a series of shredders, hammermills, trommels, screens, magnets, and density classifiers to sort the waste, extracting metals (ferrous and nonferrous), glass, and paper fractions. Manual picking has also been used in some facilities. No single technical approach is used in front-end systems. Many of the firms offering this technology say that their specific equipment or their system configuration is proprietary. The products from these processes have in some instances been of poorer quality than source-separated products (discussed in this section), limiting their marketability.

Intermediate Processing

A critical step in the necessary sequence of events that leads to actual recycling is a manufacturing operation in the preparation of the materials to meet the end user's specifications. This can involve hand separation, removal of contaminants, shredding, baling, densification, and other steps. The capability to do each varies with the types of processor and the materials to be prepared.

Secondary Materials Industry. The secondary materials industries, with their businesses built around industrial, converting, retail, and consumer source of scrap, are well equipped to process materials. In general, the scrap metal processors and the paper packing firms have adequate capacity to process all recovered materials. Scrap yards may be equipped with large shredders, shears, densifiers, balers, and other mechanical devices for preparation of materials. Increased processing is accomplished by adding work shifts or by operating equipment more hours. Usually the private industry processors end up handling a very high percentage of recovered materials, even if they come from community-based programs.

In addition to processing capability, the established scrap dealers have access to markets and can sell material for which demand exists and for which there is economic value.

Beverage Container Recovery System. The processing steps are not complex at privately-operated beverage container processing centers. Aluminum cans are sorted, shredded, and baled for shipment. Glass is crushed and placed in containers for shipment. PET containers are baled. The linkage to the market is usually direct to the end user--aluminum smelter, glass container plant, or a marketer of PET.

The deposit states vary in sophistication. Retailers handle returns, which are then either shipped to the bottler or wholesaler or to a third party that operates a MRF.* The bottlers and wholesalers process on-site and usually have arrangements with a market. The MRFs often provide pickup of redeemed containers from the retailer. The only difference is ownership and the materials that are accepted, since they are owned by or under contract to soft drink bottlers and/or beer wholesalers.

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* MRF is a relatively new term to designate a materials recovery facility; a similar term--IPF--is an intermediate processing facility.

Community-Based Programs. Intermediate processing facilities (IPF) or materials recovery facilities (MRF) are centralized locations that accept delivery of either separated and/or commingled recyclables. Depending on the collection method and schedule and the degrees of labor intensity pursued, these facilities can either involve manual sorting and picking or highly automated mechanized separation procedures. They typically receive, sort, and clean the materials and prepare them to market specification. IPFs and MRFs also perform an aggregation and temporary storage or inventory function. This aggregation is important in order to have large shipment quantities, thereby obtaining the most favorable freight rates.

IPFs and MRFs produce solid waste residues of 10 to 15 percent from the processing done by the facility, just like any other plant. Proponents of commingled collection with processing facilities claim that these centers produce cleaner, more consistent products than source separated materials that are not further processed.

Operators of IPFs and MRFs then market the prepared materials via secondary materials brokers, processors, or sometimes direct to end users.

Mechanical Processing. By practice, mechanical processing systems are intermediate processors, since they are usually "front end" systems at RDF facilities. They utilize trommeling, magnetic separation, and other mechanical preparation steps. For example, Delaware has a mechanical processing plant. Because materials are recovered from commingled wastes, they often are preparable only to minimum secondary materials standards.

Marketing from mechanical processing systems i usually via secondary materials processors or brokers; but is sometimes direct to end users.

Economics of Recycling

There are significant differences between strictly private sector recycling operations and those tied to other solid waste management programs. These are described below.

Secondary Materials Industry. The traditional private sector industry operates as demand-driven businesses with a profit objective. Thus, when demand is high relative to supply, they raise buying prices and "draw" scrap from unrecovered sources and by diversion from solid waste. They then process and market the scrap at the market price. The costs consist of three principal components: buying price, processing cost, and marketing costs, e.g., overhead, freight, and profit.

When demand is low relative to supply, they lower buying prices and, as a result, do not recover as much recyclable materials. Some materials, such as metals, may simply be stored temporarily at generators' locations or simply not recovered and left in "inventory" as undemolished buildings, bridges, equipment, auto hulks, and the like. Others, such as paper and lower-quality metals, may simply go into the solid waste stream for permanent disposal.

Because the paper and metals secondary materials industries are the most extensively developed and least dependent on MSW sources,* they operate within an economic system driven exclusively by economics (cost and value) and markets for their products. It is understandable that many of these businesses have been concerned about new sources of recovered materials not related to supply/demand forces, i.e., community-based programs or mechanical processing facilities that simply recover materials whether there are recycling applications for them or not. In other words, the economics of secondary materials industries are dependent upon using nonrecovery and the solid waste stream as the "surge tank" to hold scrap for later recovery or simply to dispose of it. When solid waste recovery programs continually add to supply, then the price that markets may pay can move adversely to the private sector's self interest.

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* MSW is the key distinction here, since considerable tonnage of postconsumer scrap and obsolete scrap is recovered from other sources.

Markets are sought and developed by secondary materials industries. However, their incentives are profits, just like any other private business. The mechanism may be cost containment, negotiated freight rates, specialized preparation and the like to lower cost and/or increase value of the scrap. Reducing recovery in bad times and increasing recovery in good times is essential to these businesses' economic welfare.

Beverage Container Recovery Systems. These systems, whether driven by mandatory deposit laws or by strictly private recovery programs, operate by a somewhat different economic system. Although totally private in nature, they operate in a different way than the traditional secondary materials industries.

In this case, the utilizing industries are principally those who assure a market for the recovered products--aluminum and glass for new containers; steel and PET for recycling to other products. They command a market price comparable to materials of the same grade. When market prices are low, the buy-back price will also be low, but the system accepts materials. In the instances of: (a) mandatory deposit system; (b) the buy-back system; and (c) the direct purchase system, the costs of recovery are absorbed by the intermediate processing center (or buy-back center) or by the soft drink bottlers and beer wholesalers. Both systems are designed to accept and to assure utilization of unrecovered materials. Thus, when costs are not fully recovered for whatever reason, the beverage industries subsidize the costs (via reduced profit and/or deposit "float"), or raise the price of beverages to retailers and thus customers. Package suppliers and/or brewers may also support the system economics.

Because these systems operate in the manufacturing and commercial sectors, the economics are generally independent of both the scrap industries and the solid waste management systems, but they are still supply/demand driven and profit-based. However, because the recovery systems are driven by legislated deposit laws or by industry's desire to offer an alternative to deposits, there is probably some subsidy of the system costs. As pointed out above, this might be accomplished by the soft drink bottlers, by the beer wholesalers or brewers, by the package manufacturers, or by retailers, who are the return point for the deposit system. To the extent costs are passed on by retailers, then the consumer provides the subsidy.

Community-Based Programs and Mechanical Processing Systems. The economics of systems based on recovery of postconsumer materials from municipal solid waste are significantly different than those of the private sector in several respects. First, the incentives are different. Almost any community-based system has as the principal incentive the reduction of solid waste requiring landfill and/or incineration. In addition, there is usually a stated or implied objective of resource conservation. These are key considerations not present as the principal incentives in the private sector. In addition, MSW systems can utilize avoided costs of disposal as a partial offset to actual costs of recovery, whereas the private sector outside MSW systems has no avoided costs. Nonetheless, the net costs can easily exceed disposal costs in areas where tipping fees are $10 to $40 per ton.

Secondary materials processors, private waste haulers, private IPC operators, nonprofit corporations, and municipalities alike can operate under the same economic parameters if there is a tie to the public sector MSW system. In addition, private waste haulers operate recovery systems based upon recovery of materials from commercial and industrial accounts, the most notable example being old corrugated boxes separated and baled at landfills or transfer stations. Where private haulers pay a disposal fee to another agency, they may also save costs of disposal, which will have a favorable impact on their economics. Sometimes they adjust waste removal fees to encourage participation by the waste generators. In this context, private waste haulers operate much like the scrap industry--by providing collection and processing of the recyclable materials.

The actual costs associated with community-based programs include both collection and processing activities. Collection costs vary greatly depending upon the type of collection used, the efficiency of the operation, the types of collection containers and/or transport vehicles used, and the types of public education program used. In situations where waste generators transport recyclables to drop-off centers, the cost to the project sponsor for collection is negligible. Costs for curbside collection of mixed recyclables can range from $35 to $75 per ton or higher. Net costs are dependent upon the quantity of recyclable materials recovered and the revenue they produce.

Processing costs for source-separated materials (e.g., paper, glass, and metal) vary with the type of materials processed. The costs of paper baling range from $9 per ton for a 100 TPD facility to approximately $20 per ton for facilities processing 10 TPD. Total costs for glass processing range from

$4 to $11 per ton for a 25 TPD facility and $1.50 to $2.20 per ton for a 160 TPD facility. Costs for processing aluminum cans range from $30 per ton for a 50 TPD facility to $20 per ton for a 200 TPD facility. Capital costs associated with processing commingled recyclable materials range from $600,000 for a 50 TPD facility to $3,000,000 for a 250 TPD facility, or approximately $12,000 per ton of operating capacity.* Operating costs for commingled systems are reported to start at $25 per ton. Capital costs of mechanical processing front-end facilities range between $10 and $40 million, resulting in a per input ton cost of $20,000 to $40,000.

The true economic value of materials collected and processed for recycling resulting from cost avoidance may be realized. In a high disposal cost circumstance, by removing a portion of the waste from the municipal solid waste stream and recycling it, the total MSW collection and disposal cost can potentially be lowered.

For example, if the tipping fee at a landfill or an energy plant is $70 per ton, then the cost avoidance is the saving which results from the difference between the cost of disposal of a ton of waste that is potentially recyclable and collecting, processing, and marketing that ton of recyclables. For instance, a typical cost to collect a ton of recyclable materials is $60, and processing cost is about $25 per ton. The collection and processing costs together result in a cost of $85 per ton to put the material in marketable condition. This is higher than the actual disposal** cost of $70 per ton; however, the revenue from the sale of materials may offset some of these costs. A net revenue of $30 per ton will result in a saving or cost avoidance for the disposal system of $15 per ton.

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* This compares to an estimated $100,000 per ton of operating capacity for a typical waste-to-energy plant.

** Note: Only disposal cost avoidance was used in the example. In the short run, solid waste collection practices will be unimpacted by recycling. However, some believe that per ton disposal costs will rise as tonnage drops, thereby offsetting the avoided disposal costs.

Also, tipping fees often do not reflect the true costs of landfilling--they do not account for certain environmental costs, for closure and post-closure costs and potential cleanup costs if a hazard develops. (See Sections E and F of this chapter).

In a market environment where recovered materials can readily be marketed and bring relatively high prices, a community-based program may operate at breakeven or profitable. The market prices and demand for postconsumer recovered materials have been quite high from the third quarter of 1985 through the second quarter of 1988.

By contrast, when demand declines and market prices decline, the converse situation arises. Community-based programs which, for example, may receive $15 to $20 per ton for old newspapers in a $45 to $50 per ton market, may receive little or nothing in a "soft" market. In fact, since recovery would continue undiminished, a community-based program could get into a situation where it had to pay for the private sector processing firms to take the material and to market its recovered materials, especially in a mandatory collection community.

In either case, the economics can switch very rapidly, since the processor's "spread" between buying and selling prices stays about the same in good and poor markets. Thus, each dollar of drop in the selling price may translate to a dollar drop in the buying price until a "floor" is reached. There are contractual protections, but these usually work to assure that a processor will take whatever tonnage is recovered and usually provide less assurance with respect to price. Thus, community-based programs can expect to operate much like any private system except that to avoid being the "surge tank" for supply/demand fluctuations, they will range from breakeven or better in high demand markets to a potentially large subsidy in lower demand markets.

Markets for Recovered Materials

Markets for recyclable materials commonly recovered from MSW vary by type of material and geographic location. markets are the industrial facilities where a recycled material is used as the raw material for the manufacture of new products. Secondary materials firms sometimes broker or transship recovered materials; for the most part, however, they process and prepare materials for shipment to a manufacturer who will use them or to an exporter who will ship them to foreign markets.

Markets vary for recyclable materials that are commonly found in MSW. Each major material in MSW is discussed in the sections that follow.

Aluminum. Aluminum, particularly aluminum beverage cans, has the highest market value per ton and a generally accessible market. The major aluminum companies that produce cans and/or can sheet have all but guaranteed a market for all the aluminum cans. They also will supply equipment and transportation for recovery programs of sufficient size to justify equipment. The price of recovered aluminum cans varies over time. The price in January 1987 was approximately $700 per ton (35 cents per pound); this increased over the year to as high as $1,400 per ton (70 cents per pound) in January 1988 and was still at that price in June 1988. The price history for used (aluminum) beverage cans, known as UBC in the trade, is displayed in Figure 2.B-1 for the period January 1983 to June 1988. Even this five and on-half year period of time shows several price cycles with the most recent y ear showing historically high prices. (The UBC prices are the highest prices for shredded beverage cans at the shipping point, i.e., prepared for shipment to the end user.)

The price that would be paid at a collection center would be about $800 per ton or 40 cents per pound. If the collection center has sufficient volume, then the UBC can be prepared for market and the full price realized. In general, however, the buying price for small quantities of UBC is 50 to 60 percent of the current market price (which is almost always quoted in cents per pound).

A curbside collection program or a buy-back or drop-off center is helped by the revenue from UBC, and while UBC may be a low percentage by weight, they will be a very high percentage of the revenue (20 to 50 percent is not unusual).

The points of consumption of UBC are limited to a few geographic locations, but the high value of the material in comparison to freight rates makes aluminum a national market, not a regional one. Although aluminum cans are used for soft drinks and beer all across the USA, their highest recovery rates take place principally in states with beverage container deposit laws, and in states where special efforts have been made by the beverage and aluminum industries to establish buy-back and drop-off centers. Although recovery rates are lower elsewhere, aluminum recycling is actively pursued in almost all principal population centers in the USA, as well as less densely-populated areas. The aluminum can (UBC) recovery business began in the early 1970s and now recovers about 50 percent of UBC nationally.

Aluminum extrusions and castings are made from different alloys and bring somewhat lower prices than UBC (see Figure 2.B-1). This scrap is usually derived from industrial sources and sold via secondary metals dealers to secondary smelters. However, the prices track each other rather closely showing that this is a commodities market. The prices shown in Figure 2.B-1

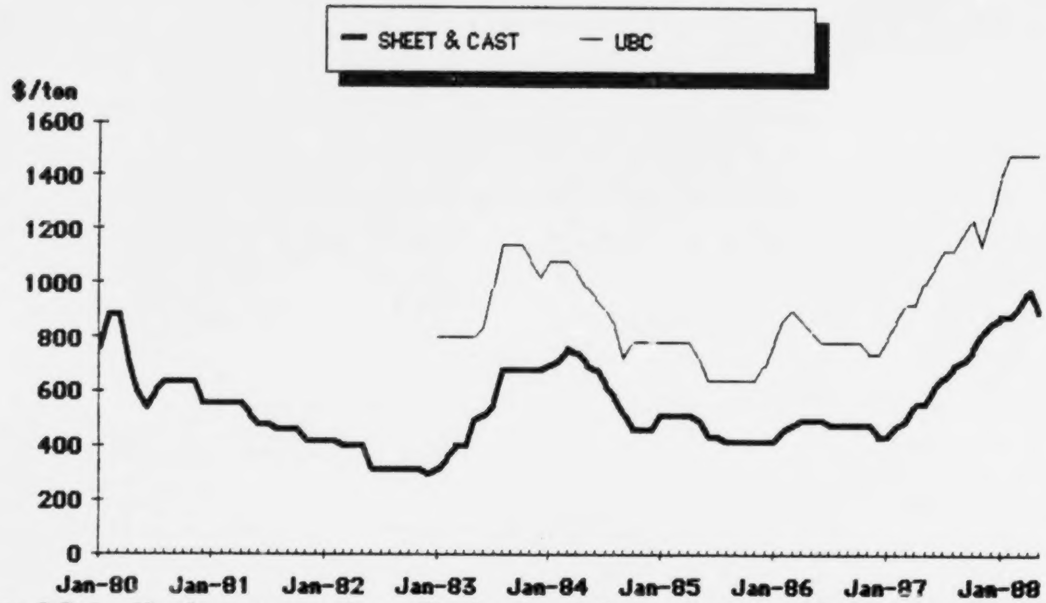

Figure 2.B-1. Aluminum scrap prices. Sheet and cast-dealers' prices, FOB-New York (Iron Age). UBC prices from private industrial source, FOB-shipper. Add $60/ton delivered.

represent scrap dealers' buying prices in the New York market and thus are stated on a different basis than UBC. Very little of this grade is recovered from community-based programs.

Additional data on aluminum may be found in Appendix A.G.

Glass. Glass has two major potential markets: as cullet (the glass industry's term for scrap glass) used to manufacture new glass containers; or to manufacture products such as fiberglass insulation. The market price for cullet is currently (May 1988) approximately $40 per ton delivered to a glass plant color sorted due to the active purchasing program by the glass industry. The glass industry has stringent specifications for cullet quality and requires separation by color in order to manufacture new containers of similar color. In addition to direct purchases by container manufacturers, broker/intermediate processors are actively purchasing glass at the present time. Further, there are some markets for glass that do not meet industry specifications, including the use of cullet in the manufacture of reflective signs and "glasphalt" (see Appendix A.B for additional detail).

The market value of glass is based on delivery at a glass plant. Transportation can be a very significant cost. In addition, the glass container industry in concentrated principally in the northeast, e.g., New Jersey; in a few places in the midwest, such as Illinois and Oklahoma; and on the west coast. Much, if not most, of the current recovery is derived from states that have beverage container deposit laws. However, the industry is expanding its efforts to recover glass, especially where shipping distances are reasonable, and community-based programs are put in place.

Glass cullet is less valuable in mandatory beverage container deposit states because the supply is plentiful there.

(One purchaser of cullet estimated green glass at $20 per ton, amber glass at $30 per ton, and flint (clear) glass at $40 per ton.)

The average price is $30 to $45 per ton delivered. However, in the central part of the USA the price is reportedly $60 to $90 per ton with freight allowances of $5 to $15 per ton. Some premium is offered for flint, while amber and green are not as valuable. As few companies accept mixed color glass. Buying prices vary widely by company and plant location, and generalities are difficult to make. In the last two years, however, prices have risen significantly, and were typically $10 to $20 per ton 10 years ago.

Ferrous Metals. Ferrous metals also have a fluctuating market. While there is minimal recovery of ferrous metals from MSW, some metals are recovered from the household waste stream--mainly cans and white goods. The principal sources of metals are industrial plants that market scrap through traditional scrap processors. For example, can manufacturers sell their trimmings to detinners who in turn sell to steel mills after the tin is removed. The value for ferrous scrap, particularly the grades that can accept metal from MSW sources, has fluctuated greatly, as can be observed in Figure 2.B-2. The primary steel producers are not generally a direct market for ferrous scrap from municipal waste. Since metals scrap must be prepared, the secondary materials industry provides a value added function for most domestic and export markets. (Additional discussion can be found in Appendix A.G.).

The Number 2 bundle price is typical of ferrous scrap that could be derived from MSW. No quoted buying price by the scrap processor was available, but it is likely $10 to $20 per ton in a $75 to $80 market, i.e., a spread of about $65 per ton. The Number 1 bundle price is shown since it is more typical for

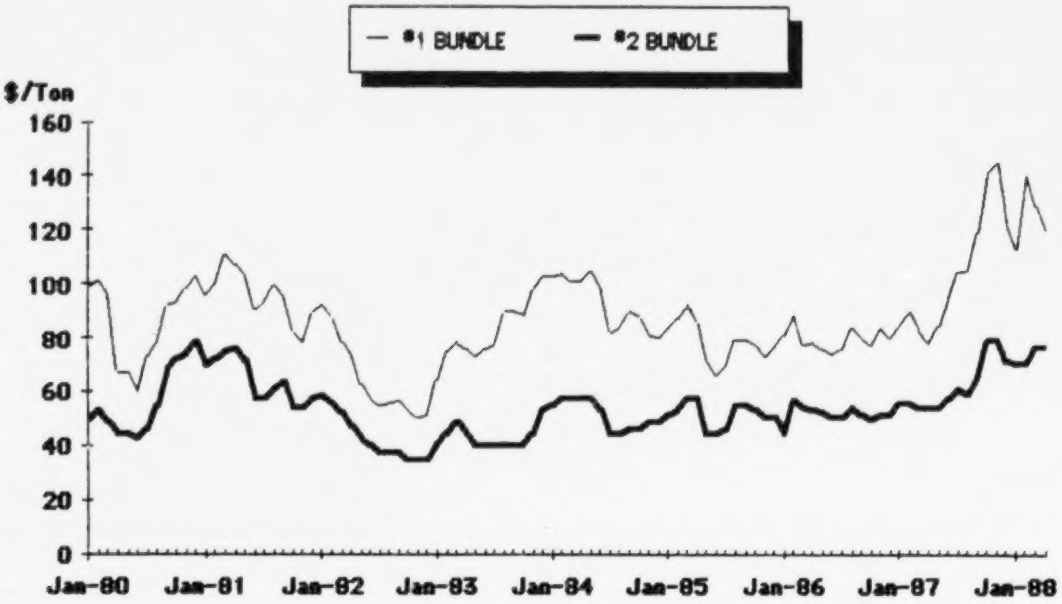

Figure 2.B-2. Chicago ferrous prices, delivered to end user e.g., steel mill (from Iron Age).

shredded automobile scrap and shredded white goods. The buying price, however, is much lower, especially for white goods.

Ferrous scrap processors in particular are concentrated principally in the largest population centers, i.e., in areas of greater than 500,000 population. In addition, they are also concentrated in the industrialized middle west and Great Lakes states. Exports are from principal east coast, west coast, and Great Lakes ports. The market price is based on delivery to the consuming mill and is quoted in the trade in dollars per gross (long) ton.

The excess supplies of unrecovered ferrous metals, the small volumes and low specifications of metals recoverable from MSW, and the regional concentration of the end-users (steel mills and foundries) against more rapid development of recovery of ferrous metals from MSW.

Finally, scrap metals dealers are not dependent on ferrous scrap derived from MSW and buy very little in comparison to their total business.

Plastics. Plastics, which are new to the group of recyclables derived from MSW, have a growing market for specific types such as PET (polyethylene terephthalate bottles), HDPE (such as milk bottles), and other packaging containers. Again, the strength of the markets depends on the cleanliness and form of the unrecovered material. Recovered plastics are finding markets in products where requirements are not as high as those requiring virgin resins (e.g., food contact).

PET is presently the most extensively recovered plastic material from MSW (one and two liter soft drink bottles). This recovery is principally derived from mandatory deposit states. Resin manufacturers, soft drink bottlers, and some community-based programs are attempting to expand recovery in areas that do not have beverage container deposits. Recycled PET is used to make fiberfill, strapping, carpet facing, geotextiles, and other products.

One major buyer of PET pays nine cents per pound, or $180 per ton, for clear PET. The price is reduced progressively based on the percent of green PET content. For example, 36 to 50 percent green bottles in a bale brings only three cents per pound ($60 per ton). The high-density polyethylene base cups are removed and recycled also, being made into new cups or other molded products. Additional discussion is found in Appendix A.C. The markets for all plastics are expected to improve in the near future as recovery and processing technologies improve.

Regionalization of consuming industries is not so much of a factor now, since the recovery of plastics scrap is very limited and in its infancy. There are some active markets for high-density polyethylene and low-density polyethylene, e.g., film. Finally, the recovery of mixed plastics is practiced in a few locations and products such as wood substitutes (e.g., posts) and concrete substitutes (e.g., parking lot bumper blocks) are produced.

Waste Paper. Waste paper markets have historically fluctuated widely. The value fluctuates with the economy, which drives the demand for secondary paper fiber (waste paper). Waste paper is primarily marketed through paper packers and brokers. There are 50 grades of waste paper identified in the trade by ISRI.*

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* Circular PS-86, "Paper Stock Standards and Practices," Paper Stock Institute of America, a division of National Association of Recycling Industries, Inc. (now Institute of Scrap Recycling Industries, Washington, D.C.)

Generally, waste paper can only be used in mills that are specifically designed for the purpose. Mills designed for pulpwood cannot easily convert, although many virgin fiber paperboard mills can and do use waste paper in the range of 5 to 35 percent of fiber requirements.

Waste paper is currently one of the major U.S. export commodities; over 4.3 million tons were shipped in 1987 out of a total of 23.9 million tons recovered. Foreign markets are subject to world wide economic conditions and rapid changes in demand. The housing industry, extremely sensitive to economic trends, uses a significant fraction of the postconsumer grades of waste paper. The type of waste paper is a major factor in marketability, value, and use. High grade waste paper (e.g., printing shop waste and certain office papers) typically enjoys the best price and most constant demand. Additional information is provided in Appendix A.A.

A price history is shown for four waste paper grades in Figures 2.B-3 through 2.B-6--old newspapers (called "news" in the trade), old corrugated boxes, mixed papers, and white ledger. These prices are mill buying prices and in the waste paper business the mill is responsible for freight costs from the dealer's plant to the mill.

In any given situation the recycling center, civic group, or business will be paid according to the market price with a "spread" by the dealer for preparation of the material. To illustrate, the market price for No. 1 news in June 1988 was $45 per ton in the Chicago market. This is the mill buying price for old newspapers. If the paper packer provides a roll-off container for a recycling center, or a paper drive, the price paid to the collector would be about $12 per ton. "Over the scales" delivered loose or in grocery sacks to the dealer's plant, the price would be about $20 per ton (it could be less).

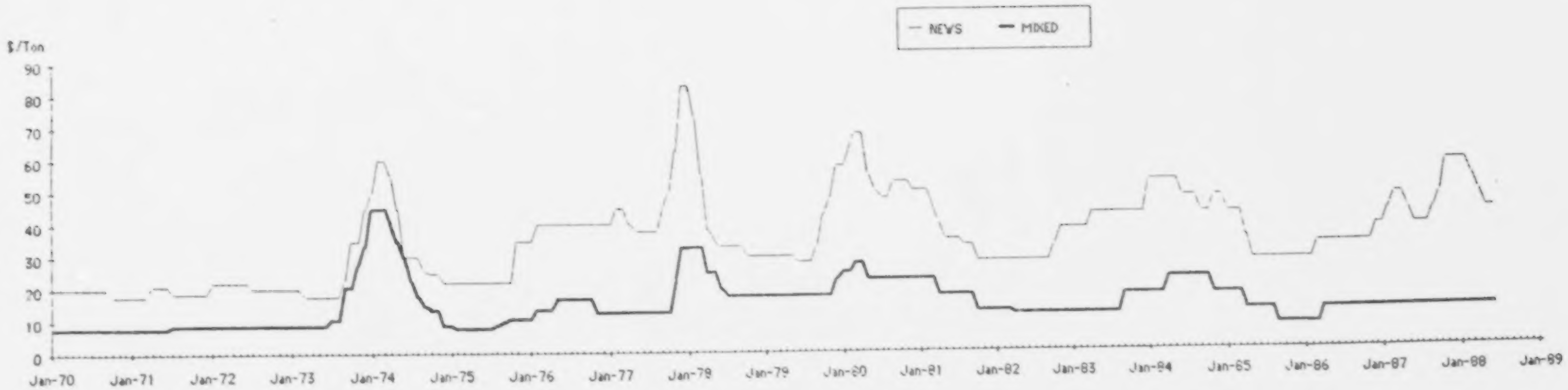

Figure 2.B-3. Posted No. 1 news and mixed paper prices in Chicago, 1970 to 1988, FOB seller's dock.

Source: Official Board Markets.

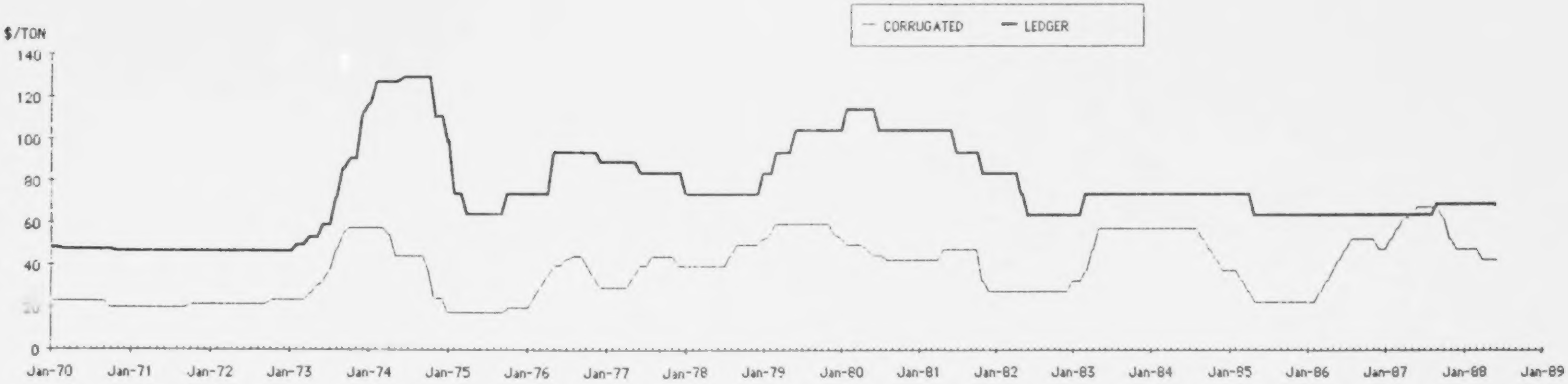

Figure 2.B-4. Posted corrugated container and sorted white ledger prices in Chicago, 1970 to 1988, FOB seller's dock.

Source: Official Board Markets.

The dealer's cost to receive, process, bale, and ship would be about $25 per ton.

If the collection center is equipped to prepare bales, the price for brokered tonnage would be $42 to $42.50 per ton. In a stronger market (higher price) the dealer would take a larger "spread" between buying and selling price, e.g., $30 per ton. In a rising market, the buying price to the generator will move up quickly at first to stimulate increased collection, then likely lag behind if the market price moves higher. If the market price falls off, the buying price will be lowered to a "floor" level. Where export markets are active, the same situation prevails, but the local price levels may be somewhat higher.

The point is that the more service that is provided by the waste paper dealer, the lower the buying price will be. The converse is true, of course, but most collectors and recycling centers are not able to provide the services that a waste paper dealer can provide. The illustration given above is current and represents a "floor price" buying level and little, if any, profit to the dealer. The principal point of this discussion is to illustrate what a recycling program will likely be paid and is not intended to be a description of the complexities of the waste paper business.

There is regionalization of waste paper demand. Exports are most commonly from ports in New York, Texas, California, and the State of Washington. Consumption of postconsumer waste paper grades is centralized in the northeast, industrialized middle west, southeast, and west coast. Since paper is sold at the point of shipment, with the end user responsible for freight, the postconsumer grades are generally shipped only 75 to 100 miles, although the supply line for deinked newsprint mills and for some users of old corrugated boxes may be longer. In general, the three principal postconsumer grades--old newspapers, old corrugated boxes, and mixed papers--sell at lower prices and are shipped short distances. Other grades such as pulp substitutes and high-grade deinking grades sell at higher prices and are shipped longer distances.

Recovery of Recyclables from Community-based Programs

The generation of industrial and commercial scrap is tied directly to the manufacturing and converting operations. The recovery is practiced via private secondary processing industries. The generation of postconsumer scrap is tied to retail sales and to population concentrations. The larger the population base, the more postconsumer waste is generated. Recovery by the private sector is tied to the location of consuming industries and to the development of the scrap processing industries.

When recovery of postconsumer waste begins to be driven by MSW practices via community-based programs, there may or may not be a market in close proximity able to use the recovered material(s).

In the northeast, interest in recycling is high. This level of interest is assumed to be related, at least in part, to the fact that where populations are dense and land is at a premium, landfill space is at a premium. The insufficiency of landfills to handle the amounts of MSW generated has caused several states to adopt mandatory recycling (i.e., recovery), including Rhode Island, New Jersey, and Connecticut. New York, Pennsylvania, and Florida are presently drafting similar legislation. California, Washington, and Oregon are very active, and other states are beginning to consider more active development of community-based programs.

Many regions have active voluntary recovery programs. Oregon has a mandatory recycling bill that requires municipalities to provide recycling programs, but participation is voluntary for citizens. Interest in recycling is typically lowest in those areas where landfill space is readily available. For example, in some areas of Texas where land is readily available, tipping fees are low, and materials markets are not seen as yielding enough revenue, the need for recycling is not currently being driven by economic necessity. However, there is growing public objection to landfills and equal opposition to incineration. Therefore, recycling initiatives in this region may stem from a political climate that embraces recycling as an environmentally-sound waste management alternative.

Commingling of recyclable materials is primarily a northeastern phenomenon, where programs are designed to simplify the citizen's efforts, maximize collection efficiency, and encourage participation. While this method is not entirely confined to the northeast region, most other regions require residents or collection crews to sort materials to avoid intermediate material processing. Even in the case of commingling, paper is kept separate from aluminum and steel cans and glass bottles.

The locations most active at present in the northeast and west coast regions do not necessarily coincide with demand for the materials recovered. Thus, as community-based programs grow in number, in success, and in geographic diversity, the integration with the much larger secondary materials industries will become much more important and challenging.

Examples of Successful Programs to Recover and Utilize Postconsumer Materials

By practice, the highest-quality materials generated in quantity are recovered first because they require the least processing, meet user specifications, and command the highest prices in the marketplace. Thus, industrial and converter scrap is recovered at very high rates. When the demand for more recyclable material increases, then postconsumer waste materials are recovered. The sources are retail stores, warehouses, assembly plants, office buildings, homes, and the like. As recovery rates rise, as they have for several years, then the recovery practices "reach" into MSW. This has been happening for the last two years at significant levels, stimulated also by a "push" from the disposal end as landfill space becomes scarcer and as costs of MSW disposal rise.

There are many success stories in recycling of postconsumer materials that are recovered from MSW for reutilization rather than disposal in landfills or incinerators.

Secondary Materials Industries and Markets. The real starting point is with the person or agency that uses a recycled product. The scrap processors and manufacturers who respond to this demand, such as scrap metal dealers and waste paper packers, are the principal processors of secondary materials. Other private programs include:

- BIRP (Beverage Industry Recycling Program) buys beverage containers and processes them for sale to metals and glass makers.
- Wellman, Inc. in South Carolina purchases PET bottles in large quantities.

- Waste haulers such as Waste Management, Inc., BFI, and a host of others no operate collection and processing programs.

Paper. Deinked newsprint is produced at over 1.3 million tons per year. Garden State Paper Co. originated the process (in 1961), and now there are at least eight mills under five separate corporate ownerships.

Over one million tons of old corrugated boxes are annually in the production of kraft linerborad and recycled linerboard in numerous mills, especially in the southeast. The same is true of recycled corrugating medium, which also utilizes over one million tons annually.

High-grade deinking grades such as computer printout and office papers are increasingly utilized to produce tissue products such as towels, toilet paper, and facial tissue.

Ferrous Metals. Metal cans are detinned in about six plants. Appliances and auto hulks are shredded in a number of installations.

Glass Containers. The use of postconsumer cullet all but disappeared in the 1960s. Now companies like Owens-Brockway, Glass Container Corporation, Anchor Hocking, and others consume about one million tons annually. Other glass plants are now especially equipped for this purpose.

Aluminum Cans. Reynolds Metals Company, Alcoa, Kaiser, and Alcan have established processes to utilize aluminum beverage cans and recycle about one-half of the cans used annually.

Plastics. A recycling business is developing in plastics with PET producers, e.g., Goodyear, Eastman Chemicals, and resin makers like Mobil Chemical Co., Dow, Amoco, and others pursuing recycling alternatives.

Community-based Programs. There are numerous examples of successful community-based materials recovery programs.

San Jose, California operates the largest curbside collection program--currently 180,000 homes. Recyclables are collected by specialized route trucks, and citizens use up to three containers for newspapers, glass, and mixed aluminum and steel cans. The contractor (Waste Management, Inc.) collects, processes at an IPC, and markets the materials. An estimated 8 percent of household waste is recovered, and home owners are charged an extra $1 per month, which supports the program along with scrap revenue. Participation is about 60 percent.

Montogomery County, Maryland operates a curbside collection program for newspapers (Garden State Paper is the contractor) in selected waste collection districts. The program recovers about 50 percent of the newspapers. A large geographic and materials recovery program expansion has been approved.

Madison, Wisconsin operates a curbside collection program for newspapers using city crews and vehicles. This program goes back to the early 1970s.

Champaign-Urbana, Illinois contracts for a curbside/drop-off program for a multitude of materials and has supported it by a landfill surcharge. The materials are marketed directly to plants and mills and/or to scrap processors.

Groton, Connecticut collects commingled newsprint, bottles, cans, and corrugated boxes from homes and businesses throughout the village. The materials are sorted and processed to market specifications at the materials processing facility. Municipal crews service 12,500 households in the village, with approximately 85 percent of those households participating in this mandatory program.

Peterborough, New Hampshire relies on citizens coming to its landfill to drop off separated newsprint, corrugated boxes, plastic, glass and metal containers, and scrap metal. Approximately half of the town's citizens utilize this system. The town is responsible for processing the material. Some materials are marketed cooperatively through the New Hampshire Resource Recovery Association and others are marketed locally.

Plymouth, Minnesota has upgraded its collection program by moving from monthly to weekly collection and providing its residents with home storage containers. The results of those changes have been that Plymouth now collects more material in a week than it used to in a month.

Many, many other programs could be described. Activity is very heavy in the mandatory recycling states of New Jersey, Rhode Island, and Connecticut, for example.

Materials Processing Programs

New Castle, Delaware. Delaware created the Delaware Solid Waste Management Authority to help solve the State's problems. The Authority, with assistance from EPA, has implemented a 1,000 TPD front-end system which recovers ferrous metals, aluminum cans, other metals (in small quantities), and glass. The glass is recovered by froth flotation and is a mixed-color product which has the appearance of sand. The authority uses the combustible fractions of the waste as fuel for a waste-to-energy facility and feedstock for a co-composting operation.

ISSUES FOR RECYCLABLES IN MSW

As more states and local communities plan for and implement materials collection and separation programs, there are a number of issues to be dealt with to assure success of their activity in the context of MSW and recycling as a SWM option. The principal issues are summarized below; they are categorized as those that applicable to the secondary materials industries in general and to those more directly related to community-based programs.

Secondary Materials Industries

Some issues that apply to the secondary materials industries in general are:

(1) the markets for all secondary materials are cyclical, although some to a greater extent than others. Thus, prices are also cyclical and price changes at the general level tend to be more dramatic (both up and down) than the end user buying price.

(2) The economy is in a period when total demand for secondary materials is at an all-time high and when the rate of recovery is increasing also. However, both total recovery and recovery rates are increasing more slowly than the potential supply of recyclable materials from both private sector activities and from MSW. Thus, there are still substantial unrecovered quantities going into waste. A number of the principal materials recoverable from solid waste are demand driven and further recovery (increase in supply) could

not be absorbed by the manufacturing sector and exporters. The principal materials in this category are newspapers, corrugated boxes, mixed papers, ferrous metals, most plastics, and rubber tires.

(3) The economics of the secondary materials industries are the same as any other private industry activity. Thus, waste materials not usable as scrap are left unrecovered or go into solid waste disposal systems. Economic forces do not penalize the secondary materials industries for recyclable materials not recovered; in fact, just the opposite. Recovered materials not marketed are an economic burden and likely end up in solid waste or at best are inventoried for "better times." The MSW disposal systems is the outlet for unusable materials whether they are uncyclable because they do not meet specifications or because of over supply.

(4) Factors in the business and consumer marketplace work at odds with increased recyclability of materials and products. For example, both packaging materials and products are becoming more complex and often utilize composite materials that are almost unrecyclable. Thus, over time the recyclable components are narrowing somewhat. Also, recycled materials still carry a negative image in some instances. This image can only be overcome over time by education.

Community-Based Programs

It is already clear that community-based programs have special characteristics with respect to their role in recycling. The principal issues in community-based programs follow:

(1) The cost of conventional disposal by landfill may give little economic support to collection and separation of materials. Many localities are at $8 to $15 per ton landfill tipping fees with adequate capacity. The incentive to move to an integrated SWM system is very low until disposal costs begin to reach $40 per ton and up and landfill capacity becomes exceedingly difficult to replace.

(2) The infrastructure to collect and process recyclables from MSW is not yet in place, although many communities do have well developed programs operating. The process of involving thousands of citizens in each community and of restructuring conventional solid waste management practices is a very long term continuing effort that will take years and substantial capital. Usually commercial, industrial, and institutional generators of MSW must be brought into a community-based program by some private means other than the curbside collection, drop-off center, and MRFs that are designed to serve homes.

(3) The local communities that have an urgent need to pursue an intensive recycling effort because of landfill limitations or other factors do not necessarily match the markets for materials that might be recovered in quantity. Thus there may be difficulties in finding markets that are suitable for the recovered materials because of geographic distribution of user industries, transportation requirements, and meeting competitive specifications.

(4) The economics of recovery of recyclables from MSW is supported principally by disposal costs that are quite high because of local circumstances. Still, in most

cases the recovery effort will not be fully supported by revenue and disposal savings but will also require additional system support in the form of increased fees or surcharges.

(5) Permanent (local) markets for recovered materials need to be developed more rapidly than they are at present. This will require partnerships not necessarily easily forged. The principal participants will be the industries manufacturing products; the secondary materials industries; private waste haulers; public bodies; and elected officials. The forging of working partnerships will be similar to that required in a waste-to-energy project. The particular issue of substance is that the need may be greater at the SWM level (collection, separation) than at the private sector level (including processing, marketing, and utilization).

(6) National policy on recycling of materials presently in MSW is in the early stages of development. Developing and implementing an agenda for action is a significant undertaking. Thus, the rate of development and time frame is in years and perhaps decades to reach achievable goals.

The issues discussed are presented to define factors to be overcome in order for community-based programs to develop a significant niche in the solid waste management hierarchy. Thus they are presented as reality and not as insurmountable obstacles. Quite the contrary, once identified they can be dealt with very effectively.

CHAPTER 2
SUMMARY OF CURRENT WASTE MANAGEMENT PRACTICES

C. COMPOSTING

Composting involves the biological degradation of organic materials. As a solid waste management technique, large-scale composting occurs under controlled conditions in the presence of oxygen. Moisture is also added to provide the proper environment for decomposition. The composting process culminates in the production of a humus-like substance that is often used as a soil amendment.

The composting process involves several major steps:

1. Waste handling and preprocessing
2. Composting

And for large-scale composting, the additional steps of:

3. Post-composting or finishing
4. Compost marketing

All four steps apply to the large-scale composting of both yard waste and mixed municipal solid waste.

1. YARD WASTE COMPOSTING

Processing leaves, grass clippings, brush, and other yard wastes can be accomplished by composting techniques ranging from small-scale backyard techniques to sophisticated, highly engineered, processes in large facilities. No absolute guidelines define the type of processing required for various needs. Some backyard composters place leaves in piles and keep them there for years, while others purchase rotating drums to turn leaves into compost in a matter of months. Centralized composting facilities also use a wide variety of processing techniques, ranging from placing yard waste in piles and turning the piles periodically with a front-end loader to shredding it, adding specific amounts of moisture, and placing it in windrows for frequent turning. Most yard waste composting facilities use the lower levels of technology but some facilities use all levels.

a. Processing Levels

Yard waste composting facilities can be classified as low-tech, medium-tech and high-tech, although in practice facilities can incorporate some aspects of each level. Each level involves an increasingly greater degree of control over aeration and moisture, usually provided by turning and watering. Greater control generally translates into higher capital and operating costs, less time required for composting, and formation of a more marketable end-product.

(1) Low-Tech

Low-tech methods involve placing leaves, grass clippings and brush in piles in residential backyards or neighborhood locations. The piles are typically turned or watered very infrequently, if at all. A general rule is that one acre is needed to compost 5,000-6,000 cubic yards of yard waste with 24 to 36 months needed for a finished compost. The finished compost is frequently low quality because no effort is normally made to separate incoming materials or screen materials (such as wood or plastics) after the process is complete. Markets are primarily limited to garden use, landfill cover, and fill material. Low-tech processing is widely used in smaller communities, individual backyards, and rural areas where volumes of yard waste are low.

(2) Medium-Tech

A medium-tech composting process involves a combination of low- and high-tech approaches. Incoming materials are placed in windrows by front-end loaders and are periodically turned and watered. Site attendants control incoming materials. Space requirements are greater than in low-tech systems because room for windrow turning is needed. About 3,000-3,500 cubic yards of yard waste can be processed on each acre. Increased turning of windrows speeds the compost time up to 18 to 24 months until an end-product is ready. Increased control of incoming material and increased control of processing improves the quality, and hence, the marketability of the end-product. Sometimes the finished compost is screened to further improve the end-product, and brush is often separated to chip and sell as mulch. Medium-tech processing costs more than low-tech processing. It is usually used in areas with ample space and with low to moderate levels of yard waste.

(3) High-Tech

High-tech yard waste processing involves specialized equipment, full-time operators, monitoring of compost conditions, and aggressive marketing. It is used where space is very limited and/or large volumes of yard waste require handling. Bagged leaves and grass are normally placed in a de-bagger, and then mixed with grass clippings and chipped into mulch. Windrows are either aerated by forced pressure or by frequent turning from specialized machines. Piles are continually monitored for temperature and moisture. A compost can be produced in 2 to 12 months. The compost is often screened to remove stones, plastic, metals and other undesirable materials to make the product more valuable. High-tech processing sites are often paved, and portions of the processing area may be covered by roofs to control moisture. Each acre of active processing activities can handle between 5,000 and 8,000 cubic yards of yard waste.

b. Existing Facilities

Because yard waste accounts for nearly one-fifth of all municipal solid waste generated, the potential for landfill abatement by composting yard waste is substantial. Although there is no firm estimate of the total number of large-scale yard waste composting sites or the total volume of waste handled, it is reasonable to assume that in excess of one hundred sites are operating and that over 100,000 tons of yard waste is composted annually.

Yard waste composting is concentrated in Northern States, where large volumes of leaves are produced in the fall, and in the Pacific Coastal States, where large volumes of vegetation are produced nearly all year. All parts of the country have at least some composting activities, however. Notable facilities include:

California:

    Davis
    Modesto
    Palo Alto
    Sacramento
    San Mateo

Delaware:

    Dover

Maryland:

    Leafco

Massachusetts:

    Wellesley

Michigan:

    LaPere
    Midland

New Jersey:

    Camden
    Fairlawn
    Maplewood
    Paramus
    Ridgewood
    Tenafly
    Westfield

New York:

    Brookhaven
    Bronx
    Brooklyn
    Mamaroneck
    Scarsdale

Pennsylvania:

    Lehigh County
    Philadelphia

Minnesota:

- Anoka County
- Carver County
- Eagan
- Hastings
- Hennepin County
- Olmsted County
- Ramsey County
- Washington County

New Hampshire:

- Durham
- Wilton

North Carolina

- Mecklenburg County

Oregon:

- Portland

Texas:

- Houston

Wisconsin:

- Appleton
- Brookfield
- Dane County

c. Costs

Capital costs for a typical small yard waste compost operation on community-owned property, such as the 4,000 ton per year site in Davis, California, amounted to $108,000 in 1981. Capital costs for a large centralized yard wste composting system for 56,000 tons per year, such as that planned by the City of Seattle, amounts to $8 million for a separate collection program, site work, buildings, processing equipment, land, and indirect costs such as engineering and start-up costs.

Operating and maintenance expenses for a small low technology yard waste composting operation such as the 4,000 ton per year Maplewood, New Jersey site, amount to about $8,000 annually for part-time labor, water, fuel, and maintenance ($2 per ton). Operation and maintenance costs for a large, centralized facility may include administrative costs, several labor categories, utilities costs, and equipment and site maintenance costs. These costs are estimated at $2.9 million per year for the planned Seattle facility ($52 per ton).

d. Products and Markets

The primary products of a yard waste composting system are mulch and compost. Mulch is typically produced by chipping wood wastes, although some mulches consist of composted leaves and grass. Mulches are used for landscaping in place of bark, sawdust or landscape rock. Compost, in turn, is the product of the compost process. It is used as a soil amendment, fill material, topsoil, and in similar applications. When sold to topsoil brokers, yard waste compost is often blended with other materials to produce a variety of products as specified by end users. Yard waste compost is not sold as a fertilizer although applications of compost can enhance the soil's ability to hold plant nutrients. Compost also improves water retention, water infiltration, soil aggregation, soil aeration, and soil porosity.

The market values of yard waste products vary by regions, quality, and final users (wholesale or retail). Prices for yard waste composts vary from $1 per cubic yard to wholesale markets to $6 per cubic yard to retail markets. The price for yard waste mulch varies from $2 per ton wholesale to as high as $9 per ton retail for a high grade product. Prices could increase if the use of the product becomes more widespread and users recognize that yard waste mulch or compost is an effective substitute for competing products. Advertising and effective marketing are vital to increasing the use of the product. Many municipal yard waste composting programs are run by public water departments with minimal experience in selling compost or mulch. Contracting for services to market the products can increase revenues and ensure a consistent quality of compost and mulch.

2. SOLID WASTE COMPOSTING

Mixed solid waste composting is an uncommon processing method in the United States. Interest in this process has increased, however, as incinerators and landfills become more difficult to site and more expensive to operate. Some components of the waste stream, such as organics and paper, are prone to decompose. Other components of the waste stream do not readily decompose and must be removed before or after the compost process. For this reason, source separation, recycling and refuse-derived fuel (RDF) systems are complementary to solid waste composting.

The process of composting mixed solid waste involves reducing the size of incoming material by grinding or shredding and removing recyclable and/or light fractions for RDF to produce a more homogeneous material. Moisture is added because composting can only be conducted if proper moisture levels are maintained. Sewage sludge is often added as a moisture source that also adds essential nutrients such as nitrogen. The addition of sludge or similar substances (such as manure) is called co-composting because two wastes are composted together.

Mixed solid waste composting can process between 30 and 60 percent of incoming waste. The remainder is either separated for recycling and preparation of RDF prior to processing or screened out of the finished compost and landfilled.

Two general mixed solid waste composting methods are practiced. Unlike backyard composting or other low-tech yard waste composting, both methods of mixed solid waste composting require construction of a physical plant and the dedicated use of heavy equipment. A fairly low-tech approach has been implemented in several low-population, low waste volume rural areas. This approach includes construction of a basic building to house equipment, the tipping floor and active compost piles. Equipment often includes a scale, front-end loaders to move garbage and construct windrows, a shredder or grinder to reduce the size of incoming waste, conveyors for moving materials, a mixer to add moisture or sludge, aeration pipes to force air into windrows, a magnet for ferrous removal, and a screen for removing materials from the finished compost. A high-tech system often includes a grapple crane, in-vessel composting equipment, a windrow turner, and a shredder for finishing compost. Sophisticated systems can be employed to separate wastes for compost and RDF in an integrated system. Operations are typically provided under turnkey or full-service arrangements from a number of manufacturers. High-tech solid waste composting is most appropriate for communities with throughput of 75 tons a day or more because it is normally not economically feasible for manufacturers to offer turnkey or full-service contracts for smaller projects.

a. Equipment Manufacturers

There are a number of compost equipment manufacturers. The major manufacturers of drums or systems include:

- Buhler-Miag is a Swiss-based company with U.S. headquarters in Minneapolis. Buhler-Miag specializes in integrating RDF and solid waste composting.
- DANO manufactures a rotating drum system for composting solid waste. Many DANO facilities incorporate sewage sludge into the process.
- Fairfield Hardy uses a system of aeration augers which rotate in circular containers to produce compost. The Delaware Reclamation Project employs this system.
- Organic Bioconversion built a compost facility in Madisonville, Kentucky in 1981. A rotating drum is used and incoming waste is hand sorted.

- *Brikollare* is a European system used at the Providence, Rhode Island facility. Waste is mixed, pressed into briquettes, and placed in a storage building to compost.

- *Seerdrum* is a system that pulverizes waste then mixes it with water (or sewage) in an attrition drum for composting.

- *Geophile International Incorporated* operates a solid waste composting facility in Dodge County, Kansas, that uses a centrifugal mill in which wastes are placed and patented enzymes added.

- *Eweson Digestor* uses a rotating drum requiring less labor than most systems. Big Sandy, Texas employs such a system.

- *PLM* is a Swedish firm with a marketing office in Connecticut. A ballistics separator separates incoming waste into fractions for RDF, compost, and landfill.

- *OTV* is a French manufacturer that uses a system similar to that of Buhler-Miag except that compost is placed in bins and turned with paddles.

b. Existing Facilities

Mixed solid waste composting facilities are much more common in Europe and Asia than in the United States. Approximately 300 facilities are located in Europe. Some European facilities have been successfully operating for over 30 years. For example, in Sweden, 24 percent of all solid waste is composted; in the Netherlands, over 17 percent of all domestic refuse is composted. Between 3 and 10 percent is composted in Switzerland, and similar volumes are composted in other European and Asian countries.

The United States has 11 mixed solid waste composting facilities, with many others in the planning stages. Planned facilities include two 400-ton per day MSW plants in Florida, two RDF residuals composting plants in Minnesota, at least 10 MSW plants in Minnesota, an RDF/compost plant in New Jersey, and potential facilities in New York, Massachusetts, North Carolina and Florida. Existing facilities are listed below:

Location	Size	Type	Manufacturer
Key West, FL	50 TPD	Solid Waste	Fairfield Hardy
St. Cloud, MN	50 TPD	Solid Waste	Eweson
Fillmore County, MN	20 TPD	Solid Waste	-------
Altoona, PA	30 TPD	Solid Waste	Fairfield Hardy
New Castle, DE	350 TPD	Co-Compost/ RDF	Fairfield Hardy
Wilmington, DE	1350 TPD	Co-Compost/ RDF	Fairfield Hardy
Big Sandy, TX	--------	Co-Compost	Eweson
Providence, RI	125 TPD	Co-Compost	Brickollare
Westerville, OH	200 TPD	Solid Waste	--------
Salisbury, MD	80 TPD	Solid Waste	Seerdrum
Dodge County, KS	30 TPD	Solid Waste	Geophile

c. Costs

Capital costs for solid waste compost equipment, buildings, and engineering range from $400,000 (1987) for a low-throughput, low-technology system such as that in Fillmore County, Minnesota, to $73 million (1983) for a higher throughput, high-technology system, such as at Wilmington, Delaware. Site costs depend on the availability of property, the size and location of the facility, and the level of services provided. Some municipalities or counties own property that could be suitable for a compost facility. Other municipalities may have to purchase property. The size of the sites ranges from 5 to 20 acres, depending on the throughput and potential buffer for visual screening.

Annual operating and maintenance expenses for a solid waste composting facility include costs for management and labor, equipment maintenance, equipment replacement, utility and fuel, building and grounds maintenance, supplies, insurance, residuals disposal, taxes, publicity, and debt service. On a per-ton basis, these costs range from $9 at the Providence, Rhode Island plant to $50 at several facilities in Sweden. Annual costs are highly variable and reported costs may not be actual costs. Items such as capital recovery, transfer of waste, transport of compost, and landfilling can add to operational costs.

d. Products and Markets

A finished solid waste compost is a coarse, humus-like soil conditioner. Chemically, solid waste compost is not a good fertilizer because nitrogen, phosphorous and sulfur levels are low. Co-composting with sewage sludge increases nitrogen levels, but also adds trace metals that may be of concern if the compost is used for consumable crops. Porosity and soil pH are increased with the addition of compost.

Byproducts generated in the mixed solid waste composting process may include ferrous metals, other metals, plastics, mixed glass cullet, paper and cardboard, and mixed rejects. Typically, cardboard and ferrous metals are marketed for recycling because they can be easily pulled from the incoming waste.

Markets for finished compost include nurseries, sod growers, vineyards, groundskeepers, landscape contractors, parks departments, road contractors, farmers, and landfill operators. Solid waste compost has supplemented or replaced manure, peat moss, mulch, or topsoil in various applications. When markets cannot purchase all the compost produced, governmental users often fill the gap. For instance, compost can be a good landfill cover for municipalities with landfills.

The markets available for the compost product and the revenue it brings depends on the quality of the product and the local or regional demand. The quality of the finished compost is measured by its particle size, color, moisture content, carbon-nitrogen ratio, and metals content. Compost will be in higher demand in areas characterized by clayey or sandy soils, erosion-prone areas, or areas with high concentrations of nursery or landscape businesses.

3. LIMITATIONS ON COMPOSTING

Composting is not a process that eliminates landfilling. It has problems similar to those of other solid waste management technologies. Particularly notable problems limiting the use of composting as a management technology include:

a. Marketing

Marketing composts or mulches from wastes is limited by competitive pricing, a lack of uniform specifications, and transport distance. A compost purchaser that substitutes a solid waste compost for a conventional product and finds that the waste compost is inferior may inhibit the sale of the material to other potential users. Word of mouth can quickly spoil the market potential if a poor quality compost is placed on the market. Some potential markets distrust any materials made from solid waste. Composts produced from wastes containing sludge also may be limited in their use if plant intake of metals is of concern. Proper testing and dissemination of test results to potential buyers is essential to dispelling fears.

b. Siting

As with other waste handling/processing facilities, compost facilities are subject to the NIMBY (not in my backyard) syndrome. Vehicle traffic, odors, dust, and noise are adverse impacts of the compost process. Buffering of 50 to 1,000 feet (depending on facility size) and locating in nonresidential areas reduce potential siting conflicts. Compost facilities require more space than comparably-sized combustion facilities because of the large areas needed for windrows.

c. Process Risks

Compost facilities, especially those committed to high-tech processing, are subject to potential equipment failures. Higher technology is more costly and unproven technology may potentially fail.

d. Environmental Risks

Compost facilities can also cause surface and ground water contamination by runoff from outdoor waste or compost curing areas. Although the runoff is normally nonhazardous, it is high in biochemical oxygen demand (BOD) and may contain low levels of heavy metals and pesticides or herbicides. Yard waste collected directly from curbs in urban areas has been known to contain low levels of lead from motor vehicle emissions. The use of sewage sludge in composting operations can cause concern about metals, odors, and airborne viruses, bacteria and molds. Odors are normally symptomatic of poor operating conditions (too much moisture or infrequent turning), and thus can be controlled by proper operation. Metals (cadmium, in particular) in sewage sludge can limit the potential land application for co-compost.

CHAPTER 2
SUMMARY OF CURRENT WASTE MANAGEMENT PRACTICES

D. COMBUSTION

Two major groups of municipal waste combustion (MWC) facilities are discussed in this section. The first are waste reduction only facilities, which burn the municipal solid waste (MSW) to reduce the volume of waste being landfilled, but do not recover the heat energy released by the combustion process. Most of these facilities were built before 1975. According to the U.S. EPA Report to Congress,[1] 21 of these are small (less than 500 tons per day) and 11 range between 500 and 1,00 tons per day. Designs for these facilities vary considerably, but they are evenly divided between two approaches: mass burn and modular (discussed below). The second group are waste-to-energy facilities, which burn the waste and then pass the hot flue gases through boilers to produce steam either for sale directly to a thermal energy user or for the production of electricity.

Three main classes of facilities used to combust MSW reflect different design approaches. These include mass burn, modular, and refuse-derived fuel (RDF) facilities. Mass burn facilities combust the waste without any preprocessing other than removing oversized items (such as refrigerators) likely to jam in the feed chutes. In the furnace, the waste moves down a series of grates (or an incline in the case of rotary combustors). Combustion air is supplied both under the grates and above to promote complete mixing and combustion of gases. Most large new mass burn combustors are expected to have waterwall furnaces for energy recovery. Many older facilities have refractory-lined walls. Mass burn combustors are field-erected and range in size from 50 to 1,000 tons per day of refuse feed per combustion train. Many facilities consist of two or more combustion trains in order to provide backups for maintenance downtime and provide capacity for large waste streams (the largest facilities to date are 3,000 tons per day).

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[1] U.S. EPA 1987. Municipal Waste Combustion Study: Recycling of Solid Waste, June 1987.

Modular combustors also burn waste without preprocessing, but are typically shop-fabricated and range in size from 5 to 100 tons per day of refuse feed per combustion train. Controlled-air design consists of two combustion chambers. In the primary chamber, combustion air is supplied at sub-stoichiometric levels, and combustion is completed in the secondary chamber, where excess air is added. Another type of modular combustor uses excess air in the primary chamber, and no additional air in the secondary chamber.

The third type of combustor uses refuse-derived fuel (RDF). The incoming MSW is processed through a series of shredders, screens, and density classifiers to separate the burnable (RDF) fraction. The resulting material, primarily paper and plastics, may be pelletized before combustion. The advantage of RDF systems is their ability to store and if necessary, transport the fuel and to produce a higher-Btu, more readily burnable fuel. Most RDF is burned in dedicated boilers designed specifically for RDF combustion, although some utilities (such as Baltimore Gas & Electric) cofire with coal in existing plants. RDF typically supplies about 15 percent of the energy in cofired applications. Ferrous metals, aluminum, and glass cullet can be recovered from the nonburnable fraction.

These three broad categories of combustion designs allow communities to select the technology that best suits their needs. Modular facilities are somewhat lower cost because of less onsite construction, and are best suited for small (up to 400 tons per day) waste flows. Mass burn facilities provide capacity for larger waste flows and offer high reliability. RDF facilities can handle a wide range of waste flows, but send a larger proportion of nonprocessible waste to landfill.

1. EXISTING FACILITIES BY TYPE OF SYSTEM

The number of municipal waste combustors reported in operation in the United States varies from study to study. The most complete counts, such as the U.S. EPA Municipal Waste Combustion Study (1987), include older waste-reduction-only units as well as more modern waste-to-energy plants. The EPA list shows 38 waste-reduction-only facilities in the United States. A comprehensive report on waste-to-energy facilities, that is, those MWC's with heat recovery, is published semiannually by the U.S. Conference of Mayors' National Resource Recovery Association. Their "City Currents" October 1987 listing is summarized as Table 2.D-1, which lists existing and planned facilities in the United States. The combined total of waste-reduction-only facilities and waste-to-energy facilities operating in 1988 is 134, of which 18 are new waste-to-energy plants starting up in 1988.

As can be seen from Table 2.D-2, operating waste-to-energy facilities are concentrated along the eastern seaboard where population is more dense and landfill space is the least available. This concentration will be more pronounced when the 18 new plants are operational; half will be located on the east coast, with the Northeast having the greatest share (four in Connecticut alone).

2. CAPACITY--PRESENT AND PLANNED

The total design capacity of the 96 waste-to-energy facilities expected to be operational by the end of 1988 will be 62,193 tons per day (TPD). The 18 new facilities represent

TABLE 2.D-1

MUNICIPAL WASTE COMBUSTION FACILITIES IN THE UNITED STATES

Type of Facility	1988 Start-Up or in Operation		Under Construction		Final Planning	
	Number of Facilities	Capacity (TPD)	Number of Facilities	Capacity (TPD)	Number of Facilities	Capacity (TPD)
Waste combustion only^1	38	13,608	0	--	0	--
Mass burn^2	42	34,657	17	21,804	3	3,850
RDF^{2,3}	21	23,100	5	5,822	3	3,897
Modular^2	33	4,436	0	--	3	780
Total	134	75,801	22	27,626	9	8,527

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[1] U.S. EPA, Municipal Waste Combustion Study: Report to Congress, June 1987. Older, waste-reduction only facilities.

[2] U.S. Conference of Mayors, NRRA, City Currents, October 1987. Waste-to-energy facilities.

[3] Refuse-derived fuel.

TABLE 2.D-2

OPERATING WASTE-TO-ENERGY FACILITIES IN THE UNITED SATES

Region[1]	Modular	Mass Burn	RDF[2]
Region I	6	6	2
Region II	4	4	2
Region III	4	6	1
Region IV	4	9	2
Region V	2	6	4
Region VI	7	1	-
Region VII	1	-	-
Region VIII	1	1	-
Region IX	-	1	-
Region X	2	2	-
Total	31	36	11

Source: "Resource Recovery Activities," City Currents, U.S. Conference of Mayors, Washington, D.C., October 1987

[1]Region I	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
Region II	New Jersey, New York, Puerto Rico, Virgin Islands
Region III	Delaware, Washington, D.C., Maryland, Pennsylvania, Virginia, West Virginia
Region IV	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee
Region V	Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin
Region VI	Arkansas, New Mexico, Texas, Louisiana
Region VII	Iowa, Kansas, Missouri, Nebraska
Region VIII	Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming
Region IX	Arizona, California, Hawaii, Nevada, American Samoa, Guam
Region X	Alaska, Idaho, Oregon, Washington

[2] Refuse-derived fuel.

19,303 TPD of that capacity, a 30-percent increase. New capacity breaks down as follows: Small modular, 513 TPD; RDF, 8,550 TPD;and mass burn, 10,240 TPD. Existing MWC capacity without heat recovery is 13,608 TPD, according to the EPA Report to Congress, for a total of 75,801 TPD current capacity. This represents 14.5 percent of the total disposal of solid waste in the United States as of 1989 and 16 percent of the postrecycling disposal amount. This is compared to Japan's incineration of 68 percent of postrecycling waste[2] and 56 percent of Sweden's household waste stream.[3]

Capacity, as shown in Table 2.C-1, is expected to increase by almost 50 percent by 1992 with 31 additional new facilities now or soon to be under construction. In addition, the "City Currents" report shows that 126 communities are in various stages of project planning. Some of these projects, such as one in New York City, will result in more than one facility, and some projects may never advance out of the planning stages. Consequently, accurate projection of future capacity is difficult to determine. However, if only the projects that are furthest along are built, then combustion could account for approximately 25 percent of the total U.S. waste disposal need by 1994.

Finally, it is important to note that these capacity totals are not cumulative; some older facilities, particularly the incinerators without energy recovery, will reach the end of their useful lives even as new capacity is coming on line. Other facilities, built during the 1970's or early 1980's, may be too costly to retrofit to meet more stringent air quality requirements and will be retired.

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[2] Herskowitz, Allen and Eugene Salerni, Inform, Inc., Garbage Management in Japan, 1987.

[3] Magnussen, Jan, Deputy Director General, National Energy Administration, Sweden. "An Environmentally Acceptable Solution to the Solid Waste Problem", Washington, D.C., March 23, 1988.

3. CAPITAL COST, COST PER TON, OTHER COST DATA

Current capital costs for waste-to-energy facilities run approximately $100,000 per ton, with no apparent economies of scale advantage for larger facilities. Recently funded project capital costs (calculated in 1988 dollars) ranged from a low of $75,600 per ton (for a 500-TPD facility) to a high of $130,000 (also for a 500-TPD facility). The causes of variation in capital costs are local labor market, varied design requirements to meet environmental concerns, and differing vendor design criteria.

Tip fees for recent facilities are equally variable, ranging from $18.14 per ton to $35.30 per ton in the first year of operation. Facilities currently in planning are projecting even higher tip fees--in the $50 to $65 range.

Several other factors influence costs and the resultant tip fees. First is the nature of the deal negotiated with the facility vendor. For example, the Town of Babylon, New York determined that the Town was not willing to accept any risks from the project that are normally undertaken by the public party. Consequently, the vendor accepted those risks, but increased the tip fee to the Town commensurately--by $10 per ton (in 1988 dollars) over the full life of the project. Other factors, such as adding an oversized pit and additional stack flue to allow for future expansion, add to the cost per ton initially, but will allow the facility to be more easily expanded at a lower cost.

Second, the ability of the project to be financed is critical. Good financing requires financially strong parties, including the jurisdiction providing the waste, the energy markets, and the construction/operation contractor or another third party to provide a backstop for the bondholders. A financially weak party in the project will hurt the sale of bonds and increase their interest rate. Although this does not increase the capital cost, it does have significant impact on the tip fee. Similarly, a well-thought-out project with guaranteed waste flow, reliable technology, and firm markets will help to reduce the interest rate.

Tax laws have an enormous effect on the tipping fee as well. Because of the Tax Reform Act of 1986, project ownership for tax purposes has begun shifting from private (with a vendor equity position in the project) to public ownership. This is because the changes have eliminated the tax benefits of private ownership. The loss of vendor equity means that source of financing other than bond funds must be used for those portions of the project that cannot be covered by tax-exempt bonds, e.g., the energy production equipment, including the turbine generator. As this equipment has become increasingly costly, the resources available to cover the cost have dwindled. If they are financed by taxable issues, the cost of these items increases the tipping fees needed to cover bond repayment.

Other costs associated with waste-to-energy projects include development costs and operations and maintenance (O&M) costs. Development costs include project planning, permitting (usually including an Environmental Impact Statement), and the costs of financing, which include costs of issuance, capitalized interest, and a debt service reserve fund. Financing costs run about 20 percent of the capital cost. Other development costs may be incurred, depending on state regulations (New Jersey, for example, has an elaborate, step-by-step project development process); the level of public concern that must be addressed; and the speed at which project planning proceeds. A community must be prepared to spend a minimum of $2 million for planning facilities of 500 TPD capacity and above. Some projects have spent millions in project planning without producing an operating facility.

O&M costs currently vary between $18 and $30 per ton (in 1988 dollars). O&M costs are higher for RDF facilities, because of additional equipment and the wear and tear on the processing lines, which demand more labor and spare parts than lines in mass burn or modular facilities. Another reason for varying O&M costs is the type of air pollution control equipment used on the plant. Scrubbers can add from $1 million to $3 million in annual O&M costs, depending on the number of units and type of scrubbers. This translates to a $2 to $10 increase in tip fees.

Finally, ash disposal costs in a state-of-the-art lined landfill will cost from $30 to $50 per ton of ash (roughly $4.50 to $7.50 per ton of waste processed). Should the ash (or flyash only) be determined to be hazardous, costs will increase sharply. The current cost to one facility for hazardous waste disposal is $150 per ton of ash (approximately $27.50 per ton of waste processed).

4. PROBLEMS

a. Mechanical/Processing Problems

The technical problems encountered by European-developed mass burn technology when first used in the United States in the 1970's have largely been eliminated in modern mass burn plants. Problems with slagging grates, eroding boiler tubes, and so forth, which result from the differences in composition of MSW in the United States and Europe, have required furnace and grate design modifications. Modern mass burn plants report very high availability rates, with some vendors guaranteeing 90 percent of design capacity, and all guaranteeing at least 85 percent. A certain amount of downtime is required for scheduled maintenance at all types of facilities.

RDF facilities were developed in the United States, and went through a period of solving mechanical and processing problems during the 1970's and early 1980's as the technology evolved. All of the presently operating RDF plants date from this time period of developing technology, and have made modifications and adopted in-plant procedures to avoid explosions and fires in the processing lines. Facilities such as that in Ames, Iowa, have been operating steadily since 1975. The six RDF plants expected to come on line in 1988 represent the next generation of modern RDF facilities, and are expected to reflect the advances made in solving technical problems encountered in older facilities.

b. Air Emissions

The emissions from waste-to-energy facilities that are of interest include metals, acid gases (primarily HCl), particulates, organics (including dioxins and furans), and, in some localities, NO_x as well.[4] EPA is presently developing regulations for new and existing MWC's to specifically address these concerns. These are scheduled for proposal in November 1989 and promulgation in December 1990. In the interim, EPA issued a set of combustion strategy elements termed "good combustion practices," which cover optimization of the combustion process, acid gas scrubbers combined with electrostatic precipitators (ESP's) or fabric filters operated at temperatures conducive to promoting condensation, and flue gas treatment for NO_x control if necessary. The guidelines from EPA reflect the advances made in emissions control in facilities worldwide, and are often referred to as "state-of-the-art" emissions control.

Modern operating facilities have computerized combustion controls, and are equipped with either ESP's or baghouses for particulate control, and lime scrubbers for acid removal. In this country, only two currently operating facilities have both scrubbers and baghouses (City of Commerce, California), and Marion County, Oregon), although most new facilities planned for start-up in 1988 will have state-of-the-art equipment. Earlier facilities may have ESP's only, and modular facilities frequently have no emissions control equipment because the two-chamber design reduces the air volume and velocity in the primary chamber, thus minimizing entrainment of particulates.

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[4] U.S. EPA 1987.

Electrostatic precipitators remove particulate matter by imparting an electrical charge to the particles and then passing the particles between parallel steel plates of opposite charge so that the particles are drawn to the plates. The plates are periodically shaken so that the particles fall to hoppers located below. Because not all particles are captured by a single "field" of electrodes and plates, additional fields are added. Each field removes about 90 percent of the particulate introduced to it.

As particulate control requirements became more stringent, the number of fields needed has increased from two, which could meet 0.08 grains per dry standard cubic foot (gr/dscf), to four or five in order to meet 0.015 or 0.010 gr/dscf. The velocity of the gases moving through the ESP also has been reduced to enhance collection, requiring wider and/or higher units.

Although ESP's can apparently achieve as good overall emissions control as fabric filters, they are less efficient at collecting particulate in the submicron range, that is, for particles less than one micron (1/10,000 inch). The control efficiency of ESP's tends to be fairly constant, so that when the "grain loading" of the flue gases entering the ESP increases, the emissions increase in proportion. The efficiency also falls as the gas volume, and thus its velocity, entering the ESP increases.

Fabric filters (baghouses) are constructed of an array of cylindrical bags, usually 20 feet long, through which the boiler exit gases are forced to flow. The bags are arranged in baghouses that are divided into sections, or modules, isolated from each other by internal dampers. Internal bypass dampers are also provided to bypass the flue gases during start-up and shutdown of the MWC train, to prevent damage to the bags that would result from condensation.

The layer of dust, or "cake," that builds up on the bags becomes an efficient filter. As the cake gets thicker, the collection efficiency increases, but so does the pressure drop suffered by the gases. When pressure drops starts to limit the ability of the induced-draft fan to pull the gases through the plant, most of the dust must be removed from the bags.

The two methods of cleaning the filter bags are known as reverse air and pulse jet. In reverse air baghouses, air is periodically blown through the bags in a reverse direction to the normal flow in order to dislodge the accumulated dust. In pulse jet baghouses, high pressure air is discharged through jets in pulses into the outlet region of the bags.

Fabric filters have been reported to achieve 0.001 gr/dscf, but in MSW applications they have generally tested at 0.003 to 0.007 gr/dscf. Their performance depends more on the cleaning cycle used than on the "grain loading" of the gases entering the baghouse, because it is the cake that captures fine particulate. More frequent cleanings can maintain a lower average pressure drop at a given level of emissions.

Acid gas emissions can be controlled through dry or wet scrubbing. The injection of dry lime powder prior to particulate emission controls has been applied in about 50 MWC's in Japan as a simple measure to reduce HCl emissions by about 50 percent.

Lime is fed directly into the furnace with MSW in the Quebec City MWC, likewise achieving about 50 percent reduction in HCl.

The pilot-scale scrubber installed at Quebec City and tested by Environment Canada under the NITEP program,[5] showed that dry injection systems preceded by a water spray to control gas temperature were as effective as spray-dry scrubbers, which are described below.

Acid gas scrubbers that spray a lime slurry into the hot gases leaving the boiler in order to contact the gases, absorb the acid, and then evaporate the water, are called spray-dry, wet-dry, or semi-dry scrubbers, as distinguished from dry (powder) injection scrubbers.

Spray-dry scrubbers in current use achieve a temperature drop of the boiler flue gases of 150^{O}F or more by evaporation of the water. Thus, 450^{O}F flue gases are cooled to 300^{O}F or less to meet this requirement. This temperature drop has a beneficial effect on air emissions.

The Quebec City tests showed that scrubber temperatures of 300^{O}F or less were increasingly effective in removing sulfur dioxide, the most difficult of the acids to remove, whereas hydrogen chloride and hydrogen fluoride are much more readily removed even at higher temperatures. These tests also showed that sulfur dioxide could be removed at efficiencies approaching 95 percent by reducing the stack temperature to 250^{O}F or lower. By lowering the temperature, heavy metals such as lead and cadmium can also be removed by a baghouse located after the scrubber. Even mercury could be condensed out at as much as 95 percent efficiency at these low temperatures.

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[5] National Incinerator Testing and Evaluation Program (NITEP), Air Pollution Control Technology, Report EPA 3/UP/Z, Canadian Ministry of the Environment, Ottawa, 1986.

The application of state-of-the-art controls, as well as the use of improved furnace design and combustion control, has resulted in dramatic reductions in emissions from waste combustion facilities. Particulate emissions have dropped from a high of 0.669 grains per dry standard cubic foot (gr/dscf)[6] to a test average of 0.10 gr/dscf for Marion County, Oregon; 0.0066 for the recently started up Bristol, Connecticut facility; and 0.0043 for City of Commerce, California.

State-of-the-art pollution control equipment also results in very low emissions of dioxins (PCDD's) and furans (PCDF's). Proper combustion temperatures (1,800°F to 2,000°F), retention time and turbulence in the furnace gases effectively destroy the dioxins contained in the wastes, but they may re-form in the cooler parts of the boiler and air pollution control equipment. Along with other organic vapors, they can be condensed onto particulate and captured by cooling the flue gases to temperatures below 300°F through an acid gas scrubber. As noted in the 1987 Report to Congress, "These low values show that alkaline scrubber/fabric filter control systems can effect good control of organic compounds like chlorinated dibenzodioxins (CDD's) and chlorinated dibenzofurans (CDF's). Low levels have also been achieved without a scrubber. Recently obtained data from Tulsa show that low concentrations might also be expected from municipal waste combustors with good combustion.[7]

Emissions will remain a concern despite the EPA guidelines. The environmental community and the public can be expected to pressure for increasingly elaborate pollution control measures and monitoring. Problems could arise over the added cost of such equipment to already expensive disposal facilities; and retrofits of existing facilities, if too inflexibly applied, could force shutdowns because of cost.

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[6] U.S. EPA 1987.

[7] U.S. EPA 1987, p. 43.

c. Ash Handling and Disposal

Two types of ash are produced by MSW combustion facilities. Bottom ash (sometimes referred to as "slag") is the residual material that falls off the bottom of the grate incline at the back of the furnace. Flyash is the lighter particles entrained in the combustion gases and is collected by the air pollution control equipment. In addition, those facilities with acid gas scrubbers will have a scrubber residue. The ash residues consist mainly of inert, insoluble materials, such as glass, clay, and dirt, as well as aluminum, iron, lead, zinc, cadmium, chromium, and nickel, along with any uncombusted organic materials. Some of these metals, when burned, form more soluble compounds and thus are of environmental concern. Metals condense onto the flyash so that this portion of the ash is more likely to show elevated levels of heavy metals than the bottom ash. In addition, some organic constituents (dioxins and furans) have been detected in MSW combustion ash in concentrations ranging from below detection limits to low parts per billion.

For mass burn combustors, flyash represents approximately 10 percent of the total ash. RDF combustors may have 50 to 75 percent flyash, and the bottom ash may be primarily aggregate with small amounts of metals due to the preprocessing of the MSW and the design of the furnaces. Modular combustors have very low gas velocities in the primary chamber, thus reducing the amount of particulate entrained in the combustion gases.

Current practice in handling ash residues in most U.S. facilities is to mix flyash with bottom ash before it enters the container used to transport it to a landfill. Some facilities collect the flyash and process it through a conditioner, adding water to maintain a damp consistency that prevents dusting, before mixing it with the bottom ash, or taking it separately to a landfill. Bottom ash is usually quenched in water, and then removed by a drag conveyor and discharged at a moisture content of about 35 to 50 percent. Some facilities use a water spray to quench the bottom ash, so that it leaves with about 15 to 20 percent moisture.

The controversy over the safe handling and disposal of ash has resulted in a number of legislative initiatives at both the Federal and State levels. Several States, including Washington and New York, are developing ash testing and management regulations. The EPA is presently developing regulations; proposed rulemaking was announced in April 1988, with proposed regulations due out in December 1988, and final regulations to be promulgated in December 1989. In the interim, EPA is presently reviewing draft guidelines that may be released for handling, transporting, storing, and disposing of MWC ash. The EPA has also outlined an ambitious research program on ash residues to establish the database needed to develop appropriate regulations and to determine appropriate beneficial uses for ash.

d. Cost and Feasibility of Retrofits

Older existing facilities generally have controls that maintain furnace temperature and furnace draft. They also have ESP emission controls.

Retrofit tests performed by Environment Canada, showed that a dramatic reduction in emissions of dioxins and other organic compounds can be achieved by providing computer-aided combustion controls and combustion chamber modifications.[a] The demonstrated improvement in combustion at the test facility indicates that existing facilities could also be similarly improved by retrofit.

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[a] NITEP.

Improvements in emission controls of existing MWC's with ESP's can be made by various methods, including refining the ESP construction and operation, and by adding more fields, if space is available. If such improvements are not sufficient, it may be necessary to retrofit with baghouses, in which case installation of a dry lime injection scrubber would bring the installation up to state-of-the-art effectiveness. However, such retrofits may be difficult or impossible because of space limitations. Costs for such retrofits must be determined on a case-by-case basis, and evaluated taking into account the remaining useful life of the facility, technical feasibility, and effectiveness of various retrofit options.

CHAPTER 2

SUMMARY OF CURRENT WASTE MANAGEMENT PRACTICES

E. LANDFILLING

1. CURRENT STATUS OF LANDFILLING

The ultimate disposal of municipal solid waste and ash residue is in municipal landfills. Preliminary assessment of EPA's Municipal Solid Waste Landfill Survey indicates there are 6,034 active municipal solid waste landfills (MSWLF's) operating inthe United States today. MSWLF's are defined as landfills that receive waste containing at least 50 percent municipal solid waste.

Landfills are located across the country but are most highly concentrated in the New England States, New York, Texas, and Wisconsin. Wisconsin, which has only 2 percent of the nation's population, has 15 percent of the nation's landfills. Texas has another 11 percent and more than twice as many landfills as California, New York, or Maine, the States with the next largest number of landfills. Together, these five states--California, Maine, New York, Texas, and Wisconsin--account for approximately 40 percent of all MSWLF's in the U.S.

EPA's MSWLF survey provides data on size, technical characteristics, remaining life, and ownership patterns of municipal landfills. To date, the results from 621 active MSWLF's that responded to the survey have been analyzed, approximately a 10 percent sample of all landfills. The information provided by these facilities has been used to estimate the characteristics of all 6,034 active landfills.

a. Size of Landfills

Table 2.E-1 summarizes the estimated size distribution of municipal landfills in tons per day (TPD) of waste received. The majority of MSWLF's, 51 percent, handle less than 17.5 TPD; 17 percent handle between 17.6 and 50 TPD; and 32 percent handle more than 50 TPD. Although the largest size category has the least number of facilities (only 157), these landfills handle 40 percent of all municipal landfill waste.

TABLE 2.E-1

SIZE DISTRIBUTION OF MUNICIPAL LANDFILLS

Average Size Landfill (TPD)	Actual Size Range (TPD)	Number	Percent	Percent of Total Waste Handled
10	1-17.5	3,093	51.3	1.6
25	17.6-50	1,028	17.0	3.8
75	51-125	791	13.1	8.6
175	126-275	442	7.3	10.9
375	276-563	334	5.5	16.3
750	564-1,125	189	3.1	18.6
1,500	>1,125	157	2.6	40.2
Total		6,034	100.0	100.0

Detail may not add to totals because of rounding.

TPD = tons per day.

Source: EPA Municipal Solid Waste Landfill Survey.

b. Composition of Waste Received

Seventy-four percent of municipal landfills receive three-quarters or more of their waste as household and commercial waste, and nearly 16 percent of the municipal landfills receive all of their waste as household and commercial. Other types of waste received by municipal landfills include: household hazardous waste, small quantity generator waste, asbestos waste, construction/demolition waste, nonhazardous industrial waste, infectious waste, incinerator ash, water treatment and sewage sludges, and miscellaneous other types.

c. Remaining Life of Landfills

An important characteristic of municipal landfills is the number of years they expect to remain open. Since 1978, an estimated 14,000 municipal landfills, or 70 percent of those operating at that time, have closed. This trend has dramatically changed the availability of landfill disposal capacity. The problem is more acute in some parts of the country. Florida, Massachusetts, New Hampshire, and New Jersey will close virtually all currently active MSWLF's within 10 years.

The majority of municipal landfills have been in operation for 20 years or less. Table 2.E-2 shows the projected drop in the number of landfills over the next 25 years and the corresponding loss in disposal capacity. Currently, municipal landfills handle an estimated 187 million tons of waste annually. The facilities remaining open in 2013, 25 years away, will be handling only 19 million tons of waste annually, a 90 percent decline.

This loss in disposal capacity must be countered with reductions in waste generation, volume reduction, and the siting of new landfills. Recent trends indicate, however, a rapid decline in the number of new facilities opening. In the early 1970's roughly 300 to 400 new municipal landfills were being built each year. During the last 10 years, this number has dropped to between 50 and 200 new landfills per year, without a corresponding increase in landfill size to compensate for lost capacity. In fact, the average size of all landfills started over the last 20 years has consistently averaged between 100 and

200 TPD. Although significant capacity is not being added now, a large number of landfills were opened between 1970 and 1977.

TABLE 2.E-2

PROJECTED NUMBER OF MUNICIPAL LANDFILLS THAT WILL REMAIN IN OPERATION OVER THE NEXT 25 YEARS

Year	Number of Landfills	Annual Quantity of Waste Handled (millions of tons)[2]
1988[1]	5,499	187
1993	3,332	131
1998	2,720	94
2003	1,594	59
2008	1,234	35
2013	1,003	19

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[1] 1988 figures reflect projected closings of 535 landfills during 1987.

Waste quantity is primarily MSW, but includes other wastes disposed of in MSW landfills.

Source: EPA Municipal Solid Waste Landfill Survey.

If the current rate of capacity development observed over the past 5 years continues over the next 5 years, only 20 million of the 56 million tons per year of capacity reported in Table 2.E-2 as going out of service will be replaced.

d. Ownership of Landfills

Local governments, including towns, townships, villages, cities, and counties own 81 percent of all landfills, as shown in Table 2.E-3. These 4,875 landfills are split fairly evenly between the different levels of local governments. In New England, New York, and several States in the central part of the country, few, if any, landfills are owned by counties. In most of the Southeastern States and in parts of the West, the majority of landfills are owned by counties. Fifteen percent of MSWLF's are privately owned and the remainder are owned by Federal and State governments.

TABLE 2.E-3

DISTRIBUTION OF LANDFILL OWNERSHIP

Operator	Number of Landfills Owned[1]	Percent of Total
Local Government	4,875	80.8
State Government	82	1.4
Federal Government	154	2.6
Privately Owned	912	15.1
Total	6,034	100.0

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[1] Total does not add to 6,034 because a few landfills did not provide ownership data.

Details may not add to totals because of rounding.

Source: EPA Municipal Solid Waste Landfill Survey.

The type of ownership correlates with an important landfill characteristic, size. Landfills operated by towns and villages are more likely to be small (over 84 percent handle less than 17.5 TPD) and are also somewhat more likely to stay in operation for more than 30 years. In contrast, 89 percent of county landfills and 91 percent of city landfills fall into the moderately sized category, handling between 10 and 275 TPD. Privately owned landfills are the most likely to be larger, with

31 percent of these handling more than 275 TPD. However, there are a number of small private landfills; nearly 37 percent of all private landfills handle less than 17.5 TPD.

e. Status of Landfilling Regulations

EPA decided in 1987 to develop its regulatory program for municipal solid waste landfills using both the Clean Air Act to address air emissions and the Resource Conservation and Recovery Act to address all other issues. Municipal landfills are regulated under Subtitle D of RCRA, which establishes a framework for coordinating Federal, State and local government management of Subtitle D wastes. The Federal role originally was to assist States in developing solid waste management plans and to establish criteria for protecting human health and the environment at Subtitle D facilities. The specific provisions of Subtitle D are as follows:

Section 4002--Federal Guidelines for State Plans. Requires EPA to promulgate guidelines to assist in the development and implementation of State solid waste management plans.

Section 4004--Criteria for Sanitary Landfills. Requires EPA to establish criteria for determining which facilities must be classified as sanitary landfills--that is, which facilities pose "no reasonable probability of adverse effects on health or the environment from the disposal of solid waste."

Section 4005--Prohibition of Open Dumps. Imposes a ban on open dumping in facilities that do not meet the criteria for sanitary landfills and requires EPA to publish an inventory of open dumps in order to assist States in upgrading or closing these facilities.

EPA issued the criteria for sanitary landfills in 1979.

These criteria state that any of the following activities may adversely affect health or the environment and cannot be practiced:

- Operating in a floodplain such that water flow is restricted or waste is washed out.
- Contributing to the taking of endangered species.
- Discharging waters to surface waters without necessary permits.
- Contaminating underground drinking water sources.
- Failing to meet requirements for waste application to land used for food chain crops.
- Failing to meet requirements for disease vector control.
- Engaging in open burning of waste.
- Failing to meet requirements to control gases, fires, bird hazards and public areas.

The Hazardous and Solid Waste Amendments (HSWA), of 1984, directed EPA to revise these regulatory requirements to further protect health and the environment, including requiring ground water monitoring and corrective action. These new rules are slated for issuance in draft form in 1988.

EPA's Air Office is developing regulations for new and existing landfills under the Clean Air Act. These regulations are scheduled for proposal in the spring of 1989. These regulations are designed to address volatile organic compounds, air toxics, odors, explosive gases, carbon dioxide, and methane. The regulations for new units will consist of Federal standards with which landfill owners must comply. At existing units, EPA will propose guidance for standards that States must either adopt in their own regulations or justify an alternative approach.

The standards, as they are currently written, call for active collection of air emissions and control, either combustion (flaring) or recovery, depending on the market for energy that could be recovered. The regulations are also likely to include a size cutoff below which the standards will not apply.

Although the Federal government is responsible for preparing regulatory guidance, it is the responsibility of States to enact and enforce regulatory programs for their landfills. This approach has resulted in differing regulatory requirements and levels of regulation across the 50 states.[1] These regulatory requirements continue to change today, particularly in States that are facing tremendous strains on their solid waste disposal capability. Some of the recent developments in selected States are as follows:

California

Currently revising landfill operating and siting requirements. No immediate capacity problem. Major problem is the lack of centralized authority over landfills as responsibility is fragmented between many agencies. Results in siting complexity.

Florida

Has had strict landfill regulations since 1985 and is now reviewing new solid waste legislation. Although it recycles 5 to 10 percent of waste now, Florida is moving toward more recycling and resource recovery plants (nine plants now handle 20 to 25 percent of all waste). New landfill regulations include requiring trained operators, liners, leachate collection systems, ground water monitoring, and closure plans. Florida is also helping local governments with recycling and has new programs for managing household hazardous waste and used oil.

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[1] U.S. Environmental Protection Agency. State Subtitle D Regulations on Municipal Solid Waste Landfills, March 1986.

Massachusetts

Has major capacity problems and now exports 15 percent of its waste to border states and to places as far away as South Carolina, Ohio and Quebec. The State recently passed solid waste management legislation requiring waste reduction and solid waste planning. A new program that will include very stringent controls on landfills is to be released in mid-1988. Its overall focus is on integrated waste management.

New Jersey

Currently exports 50 percent of its solid waste to other states. Legislation was passed to stop waste exporting by 1992 and to mandate recycling. The program will require siting of new landfills and resource recovery facilities. New Jersey is considering legislation that would empower the State to site facilities in an emergency.

Wisconsin

Has over 15 percent of the nation's landfills, many of them small town dumps. It is now implementing a new program passed in 1986. The State can take an active role in siting by designating a site technically acceptable, after which it must be accepted by a town. Wisconsin has a major recycling program, including a $10 charge on new tires to fund a tire disposal operation.

2. COSTS AND REVENUES FOR LANDFILLS

Our current practices of municipal solid waste generation and disposal are largely driven by the economic choices that people make every day. The cost of landfill disposal provides the foundation for these economic choices. If the cost of landfilling is or is perceived to be extremely low, there will be no economic incentives to reduce the amount of waste we generate. On the other hand, when landfilling costs escalate, interest in reducing waste volumes and recycling rises. The cost of landfill disposal can be viewed from three perspectives. The first is the true cost of operating landfills. What does it really cost to design, construct, operate, and close a landfill? The second is the discrepancy between true cost and perceived cost. Do landfill owners/operators know what it costs to run their facilities? The final point is the connection between the cost and the charges imposed on the waste generator. Do landfill users pay their fair share and receive the proper information to make informed choices on the cost of waste generation and disposal?

The entire direct costs of operating a landfill are seldom accounted for by most landfill owners/operators, particularly public entities. Frequently, the costs of landfill operations are thought of as the day-to-day costs of personnel, equipment, operation and maintenance, and occasional capital acquisition. Even these costs can become blurred when equipment and personnel are shared with other local agencies such as a Department of Public Works.

Understanding the true cost of landfill operations requires not only a full accounting of day-to-day costs, but also an accounting of the other major costs that are incurred over the life cycle of a facility. These include the costs of:

- Planning and siting
- Land acquisition
- Design and construction
- Equipment

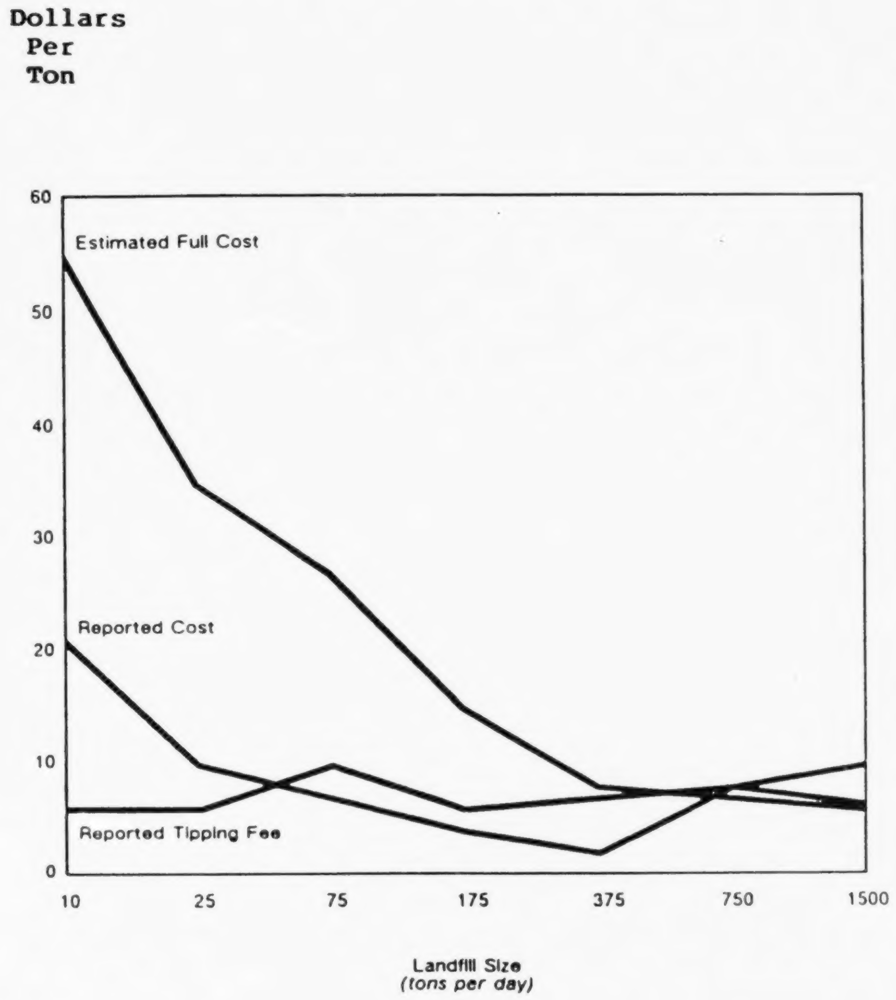
- Environmental monitoring
- Planning for closure
- Closure
- Postclosure care
- Cleanup, if necessary

Once these costs are estimated, they should be arrayed on a time line that covers the full life cycle of the facility. The cost elements can then be distributed over each year of operation using financial discounting analysis. The end result of this exercise will be an estimate of what it realistically costs to run a landfill each year or for each unit of waste disposed. These true costs also represent the amount of revenue (taxes and/or tipping fees) required to break even on the operation.

Figure 2.E-1 presents three cost/revenue curves that are useful in comparing true costs, perceived costs, and actual charges. The curve at the top of the figure represents an estimate of the true cost per ton of waste disposed to operate landfills that handle between 10 and 1,500 TPD under current Federal regulations. (New Subtitle D regulations will shift this curve upwards.) The curve illustrates tremendous economies of scale in operating larger landfills. At a 10 TPD facility, true costs are $55 per ton; at 1,500 TPD facilities, true costs are closer to $6 per ton. This disparity should encourage regional cooperation to reduce disposal costs through the use of larger facilities, but it must be balanced against higher transportation costs.

Figure 2.E-1

ESTIMATED AND REPORTED COSTS TO OPERATE A LANDFILL AND REPORTED TIPPING FEES



Source: U.S. EPA Municipal Solid Waste Landfill Survey and Subtitle D Regulatory Impact Analysis.

The next curve in the figure presents the median annual operating costs reported for landfills around the country in the MSWLF survey. This curve shows roughly the same pattern as the true cost curve. However, the reported costs are much lower than the true costs for smaller landfills. The gap between these curves represents either (1) the difference between what we perceive our landfilling costs to be and what they actually are or (2) the fact that smaller landfills do not spend the true cost of operating correctly. The gap between true cost and reported cost disappears for large landfills over 750 TPD. This would seem to suggest that large landfills do account for true costs while smaller ones do not.

The final curve in Figure 2.E-1 presents median reported residential and commercial tipping fees. This curve identifies two interesting points. The first point is that smaller landfills, when they do collect tipping fees (this issue is discussed more fully below), tend to underprice this service even relative to the recognized day-to-day costs of running the landfill, which is itself far below true cost. The second point is that for larger landfills the tipping fee is set close to the reported costs of operation.

The next issue is how revenues are generated for running landfills; in other words, how do we pay for landfill disposal of solid waste? Figure 2.E-1 presented one revenue source, tipping fees. The other major revenue source is tax revenues from local jurisdictions. These major revenue sources can also be enhanced with revenues from methane sales and recycled products recovered from the waste stream. Approximately 30 percent of all landfills receive virtually all revenues from tipping fees, and approximately 35 percent receive all revenues from taxes. The remaining 35 percent of landfills receive a mixture of funding from these two sources.

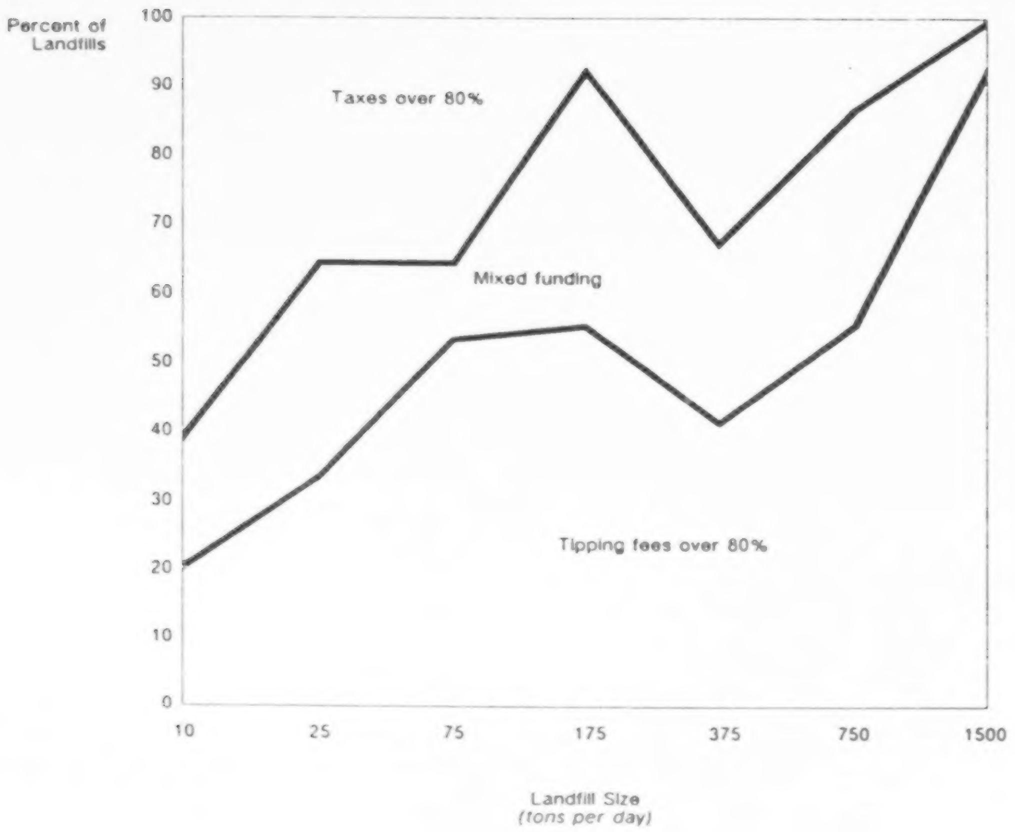
The use of tipping fees versus taxes has several important implications. The first is recognition of what solid waste disposal costs. When these costs are included in taxes, the average citizen has no idea of the cost of garbage disposal. The second implication is for the overall funding level of the landfill. Tax-supported landfills are typically underfunded relative to true costs and, therefore, are probably not run as well as tipping-fee supported landfills.

Two factors seem to have the greatest influence on the use of taxes versus tipping fees across the country: the size of the landfill and its ownership. Figure 2.E-2 illustrates the percentage of landfills receiving 80 percent or more of their revenues from taxes or tipping fees relative to landfill size. An obvious pattern emerges from this figure: that smaller facilities rely heavily on tax support and that the largest facilities rely on tipping fees plus other non-tax revenue. These findings, combined with the observations from Figure 2.E-1, seem to indicate that large landfills recognize true costs and charge them to their users. Large landfills also handle the vast majority of municipal solid waste in the United States.

Ownership is the other factor that seems to relate to the use of tipping fees, as presented in Table 2.E-4. Private operators of landfills tend to rely more heavily on tipping fees than other entities. However, private operators also tend to operate larger landfills, which may be the most important underlying variable.

FIGURE 2.E-2

PRIMARY REVENUE SOURCES FOR LANDFILL OPERATIONS



Source: U.S. EPA Municipal Solid Waste Landfill Survey.

TABLE 2.E-4

USE OF TIPPING FEES AND LANDFILL OWNERSHIP

Ownership	Percent of Landfills With Over 80% of Revenues From Tip Fees
Private	72
City	43
Federal	36
State	33
County	31
Town, Township, and Other Local	13

The use of tipping fees also varies by regions as do the median tipping fees, which are presented in Table 2.E-5 for the three largest landfill sizes. The use of tipping fees varies widely, with only 18 percent of Region I (New England) landfills using tipping fees and 53 percent of Region VI (South Central States) landfills using tipping fees. Median tipping fees reported in the table should be considered illustrative, as many of these figures are based on information from only one landfill.

3. PROBLEMS WITH LANDFILLS

By their very nature, municipal solid waste landfills will always be part of our society. They are required for the disposal of, at least, nonrecyclable items, incinerator/resource recovery ash, and residuals from recycling operations. And yet, there are many problems with landfills. First, there is a rapidly shrinking supply of landfills and landfill disposal capacity. Second, it is very difficult to site new landfills and expand existing ones because of local concerns over environmental

TABLE 2.E-5

USE OF TIPPING FEES AND REPORTED TIPPING FEES ACROSS EPA REGIONS

EPA Region	Percent of Landfills With Over 80% of Revenues From Tip Fees	Median Tip Fees* (In dollars per ton) 375 TPD	750 TPD	1500 TPD
I	18	$25	25	NR
II	33	10	18	12
III	23	16	13	38
IV	28	7	6.5	10
V	26	10	4.5	6
VI	53	3	NR	23
VII	43	NR	NR	4
VIII	44	NR	NR	NR
IX	28	NR	1	8
X	51	33	30	NR

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*Note: Many observations are based on one landfill only and may not be statistically representative of the region.

NR = None reported.

Source: U.S. EPA Municipal Solid Waste Landfill Survey and Calculations by Temple, Barker & Sloane, Inc.

and health risks. Third, the landfills now in operation, particularly those predating 1980, can pose significant environmental and health risks because of their poor siting and design and the types of materials placed in them. The Subtitle D report to Congress points out that 25 percent of all landfills have been cited for regulatory violations. Additionally, 184 MSW landfills are listed on the Superfund National Priority List. Risks from landfills result primarily from ground and surface water contamination, potentially affecting drinking water sources, and from uncontrolled gas migration.

These problems exist for a variety of reasons, but probably the most important is inadequacy of regulatory control. If landfills had been adequately regulated to protect human health and the environment, we would not have the health risks and environmental damage from municipal landfills that we have today.[2] A full 22 percent of the Superfund National Priority List sites are municipal solid waste landfills.

The question of the adequacy of landfill regulations is being addressed as part of the Subtitle D program. However, this will correct problems for the future, not the past. In the meantime, the effect of less-than-adequate regulation and the resulting damage to health and the environment has been a tremendous increase in the public's concern over open and closed landfills. The net result is that local citizens do not want municipal landfills sited nearby. It will take a long time to quell these fears, even if improved landfill design and operating requirements were implemented today.

Given the difficulty of siting new landfills and the inevitable fact that existing landfills will reach capacity and close, we are now running into landfill capacity shortages. Over the short term, waste volumes will have to be reduced to accommodate these shortages. In the longer term, new facilities must be sited, which will require a building of the public trust through education and a demonstrated ability to operate landfills while protecting human health and the environment.

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[2] U.S. EPA, Report to Congress: Solid Waste Disposal in the United States, April 15, 1988.

The problems associated with MSW landfills are best summarized by the major findings in the Report to Congress.

- There is a shortage of MSW landfill capacity in some areas.
- Environmental and health impacts from MSW landfills have been identified.
- Federal and State Subtitle D regulations are inadequate.
- State implementation of State regulations is inadequate.
- Limited Federal assistance to State and local governments is available.

CHAPTER 2

SUMMARY OF CURRENT WASTE MANAGEMENT PRACTICES

F. COMPARING MANAGEMENT OPTIONS

The current mix of solid waste management approaches has evolved over time based on a combination of economic, political, legal, and technical factors. Evaluating these various approaches is necessary so that each community can provide waste management services as effectively and efficiently as possible. Landfills now handle over 80 percent of the MSW generated. Whether this allocation of waste management resources is justified from an economic standpoint is a question that should be reexamined. Comparing options, however, is a complex task. The true costs of alternative approaches are difficult to determine, and information on the health and environmental effects of the various management options is limited and difficult to quantify.

Any nationwide comparison of waste management options is limited by two factors: the difficulty of comparing local, site-driven programs at a national level, and the lack of adequate analyses of comparative costs and risks. Characterizing current practices from a national perspective is complicated by the fact that decisions are dominated by location-specific factors that drive the final outcome. Aggregating these factors is impossible at a national level. A national perspective can provide guidance to localities on the relevant issue to consider and can add a broader range of concerns than typically addressed by individual communities. However, this national perspective may at times be at odds with local goals.

The local nature of solid waste issues also explains the lack of available comparisons among different waste management approaches. Specific communities have made efforts to calculate the true costs of alternatives, but these are of limited value outside the particular community. What is useful to a broader audience is the methodology used to describe and value alternative approaches.

1. MEASURES FOR COMPARING MANAGEMENT OPTIONS

Decision makers in local communities should consider both economic and noneconomic issues when assessing current and alternative solid waste management approaches. In regard to costs, the basic message is simple: assess management options based upon a complete accounting of total costs. Such a complete accounting, however, may be difficult or impossible. On the one hand, political pressures and time and budget constraints may prevent the drawing of a true picture. On the other hand, not all costs are obvious or even quantifiable. The environmental and health aspects of different waste management options may also be difficult to measure.

a. True Costs of Waste Management Alternatives

The true costs of an option incorporate both its current and future consequences. In the case of solid waste management, some costs, such as the cost of an incinerator, are obvious. Other costs, such as the costs of finding a site for the incinerator and a site to handle incinerator ash, are less obvious. Even less apparent are the savings realized by not having to pursue other avenues, such as the savings realized on existing landfill costs when an incinerator is used.

Moreover, external factors may distort the true cost of providing a service. If the cost of landfilling waste is artificially subsidized, for example, or if a community underestimates its costs and its tipping fees, then alternative approaches will not be able to compete on an equal basis. Recycling or incineration, which might be viable alternatives if landfill prices were higher, appear to be economically infeasible.

Thus, any assessment of current practices must examine the true costs of each component of the program, including those costs that are typically included and those that, for one reason or another, may not be included.

(1) Costs That are Typically Included

Many communities with waste management facilities do not know the true cost of the facility. Instead, they focus on the most obvious cost component, the day-to-day operating costs. Operating costs include outlays for labor, maintenance and repair of equipment, equipment replacement, fuel, and utilities. In some cases, they include amortized costs of equipment or buildings.

Offsetting revenues may also be included in the overall operating costs of waste management facilities. Revenues from the sale of scrap materials or energy by recycling and waste-to-energy facilities, for example, may reduce the apparent cost of the program if used to offset operating costs.

Finally, some types of facilities, such as incinerators and landfills, can more easily quantify costs and therefore recover them with appropriate tipping fees or other charges.

(2) Costs That May not be Included

Planning and Siting: Among the costs that may not be included when assessing the total cost of waste management alternatives are those associated with planning and siting activities before construction. These costs include design costs, environmental impact statement, legal fees, public hearings, financing costs, and plan revisions resulting from public comments.

Land: Land costs may be excluded from project costs because the community already owns the land that is necessary for certain types of waste management projects. Even if no transfer of funds is involved when land is set aside for such a use, a cost to the community is incurred. One way of quantifying this cost is to estimate the amount of revenue lost by restricting the current and future use of the land. The current revenue would equal that generated if the land were sold or leased, and future revenues might be lessened by restrictions on the land after the waste management facility closes.

External Agreements: Many waste management projects involve complex arrangements with equipment vendors, private firms, or neighboring communities on such issues as liability, transfer payments, and waste guarantees. These agreements often impose costs on the operator and should be part of the total project.

Environmental Impacts: The final category of excluded costs relate to the human health and environmental impacts of waste management facilities. The costs required to remedy future damages, for example, are difficult to quantity. One such cost is the cost of insurance to cover damages and cleanup from spills or releases. Another is the cost of reserves set aside to cover such environmental damages.

Offsetting Costs: On the other hand, certain cost offsets may be overlooked. These might include savings on operating costs at existing landfills if a complementary waste reducing program such as recycling, incineration, or composting, is in effect. In addition, the savings realized by delaying construction must be considered. The cost of building new landfills is increasing steadily because of liability costs and regulatory compliance costs. Any delay can be viewed as money not spent. At the same time, because existing landfills may not be as safe as new ones, a higher risk of release may actually increase total costs as the life of a landfill is extended.

(3) Additional Cost Considerations

Not all cost issues are relevant to local decision makers. Some of the costs involved in waste management practices are more important at the regional or national level. These include the effects of various waste management options on natural resource depletion and preservation. All options (except source reduction) require land for facilities, with landfilling requiring the most space. Some options preserve or create resources; burning can create energy and landfills can have gas recovery. Recycling and source reduction have the greatest impact on resources, because they conserve virgin materials.

Although local decision makers cannot be expected to make these larger concerns the controlling factors when choosing among local waste management options, they can be guided by the Federal government, which can encourage the consideration of broader implications and the local reinforcement of national priorities.

b. Other Environmental and Human Health Effects

Some of the adverse environmental and health effects of waste management approaches can be measured in terms of dollars, such as the cost to mitigate the effects of or to clean up contaminated groundwater. Other adverse environmental effects are difficult to quantify and vary in severity from town to town. Examples include increased traffic at recycling centers or noise and odors from landfills. Local officials should include both types of factors in evaluating current waste management systems.

2. THE PROCESS OF COMPARING MANAGEMENT OPTIONS

Comparisons of waste management approaches are hindered by the fact that the cost, health, and environmental effects of alternatives vary across communities. National-level, or aggregate, cost estimates, for example, necessarily exclude some site-specific factors and are therefore of little help to local decision makers whose major concerns are community-specific. Given these difficulties, EPA's focus is primarily on the process of comparing options: that communities fairly compare alternative approaches to waste management.

a. Cost Comparison

Waste management techniques whose true costs exceed perceived or advertised costs are overused. Conversely, if the perceived costs exceed true costs, communities will underuse the option.

Landfilling: Although it is difficult to generalize across communities with widely differing waste problems, demographics, and economies, it is clear that true costs do not consistently guide the pricing of landfilling. Therefore, the allocation of resources to various waste management options is skewed in favor of landfilling. For most of the operating municipal solid waste landfills:

- True cost exceeds reported cost by a factor of almost three. This is the case for over 90 percent of the landfills that handle less than 560 tons per day.

- Tipping fees do not cover even reported costs for landfills smaller than 50 tons per day (about two-thirds of the landfills).

- Taxes, not user charges, provide most of the revenue at most landfills.

Most waste, however, is managed in larger landfill facilities. Nearly 60 percent of the waste is handled at only 6 percent of the landfills. At these units:

- Tipping fees are more likely to cover true costs.

- Tipping fees provide the majority of the revenue.

These aggregate estimates from survey data indicate that landfilling appears to be less expensive to many communities and citizens than it really is. This disparity between true and reported costs also makes alternatives to landfilling look less attractive. Other waste management alternatives are far less prevalent than landfilling, but if the true costs of landfilling are recognized and passed on to users, shifts to these alternatives are likely. The prevalence of landfilling in itself also contributes to its continued use. Most communities think in terms of single solutions to waste management problems, and landfills have traditionally provided that solution.

Combustion: Unlike landfills, municipal waste combustors have true costs that track well with reported costs. These facilities are generally financed as stand-alone projects and in order to receive financing, the stream of revenues must be as reliable and accurate as possible. Revenues come from energy sales (generally 25 to 50 percent) and other sources, tipping fees and/or general funds. In the current system, therefore, the costs of incineration are accurately captured in reported costs.

Composting and Recycling: The costs of composting and recycling programs depend on the subset of the waste stream affected and the approach taken. Both of these approaches are in a transition period in regard to costs and economics. Past recycling programs conducted by municipalities or nonprofit groups often ran on slim or negative margins, relying heavily on volunteer labor and contributions. In situations where participants placed a large personal value on recyling as a "good idea," nonprofit ventures developed a following and were successful. Of course, recycling in the private sector has always and must continue to operate for profit.

To some extent, these programs are evaluated differently than other waste management options. Recycling programs are evaluated by local governments as stand-alone businesses whose costs must be covered by revenues in order to be justified. A different, but more appropriate view, is to weigh the costs of recycling against those of landfilling. The major factor in the economics of composting and recycling is the avoided cost of diverting waste from landfills and incinerators. As avoided costs climb, composting and recycling will become more attractive. As an example, one city, San Jose, California, has done a definitive cost analysis which compares curbside collection and recycling with total reliance on landfilling. In the near term, landfilling is still cheaper; however, future regulatory costs may shift the balance.[1]

Source Reduction: Finally, source reduction is in a category by itself. Source reduction is not accomplished by local officials who deal with waste management issues (although they may affect waste generation by imposing taxes, fees, deposits, or bans on materials). Instead, source reduction starts with consumer and producer decisions, influenced by the economics of raw and scrap materials, processing costs, and markets. It is extremely difficult to compare the costs of source reduction with other management costs because source reduction can take so many forms and costs can vary widely.

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[1] "Economics of Curbside Recycling in the City of San Jose, California," California Energy Commission, 1987.

b. Human Health and the Fnvironment

We have less information about the comparative health and environmental effects of waste management alternatives. As with costs, the factors that affect human health and the environment vary from site to site. Comparing incineration to landfilling, for example, using aggregate estimates or "typical" settings would be misleading. The scope of national risks from these management practices is addressed in the Reports to Congress on solid waste disposal and on municipal waste combustion and in regulatory analyses of future rulemakings, e.g., the revised Subtitle D criteria for municipal landfills.

Landfilling: Because landfilling is so common, its effects are the most studied. Landfill hazards vary substantially: some units have operated for years with minimal controls and have caused few problems, while others have ended up on the Superfund National Priorities List. With the upcoming landfill criteria revisions, new landfills are likely to be safer than those constructed under previous guidelines.

Combustion: Waste combustion risks are quite controversial, both for air emissions and ash management. As with landfilling, Federal standards for ash disposal and for emissions are likely in the near future. Again, local parameters largely control the relative risks of combustion as a waste management option, so that national-level comparisons of this alternative with others are impossible.

Composting and Recycling: Composting removes much of the organic material from solid waste, and may assist in reducing the toxicity of landfill leachate, but composting facilities may generate waste waters that often must be treated. The compost may also retain organic materials (such as pesticides) and inorganic materials. Depending on the final use of the compost, those constituents may be released to the environment.

Recycling is often perceived as a relatively benign form of waste management, although recycling certain materials can create hazards. The potential for mismanagement is shown by the fact that, like landfills, some recycling facilities appear on the Superfund National Priorities List.

Source Reduction: Source reduction, like recycling, has low perceived risks associated with it, but replacement or degradable products may also have undesirable properties. Whether these are environmentally preferable to land disposal or incineration, depends on the particular material.

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F. COMPARING MANAGEMENT OPTIONS

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CHAPTER 3

OBSTACLES TO MORE EFFECTIVE WASTE MANAGEMENT

A. SITING

Siting of landfills, incinerators, and even recycling operations is extremely difficult, at best. Yet, it is imperative that new facilities be sited as the need arises. New facilities are so difficult to site because of public opposition; often referred to as the "not in my backyard" or NIMBY syndrome, and the frequent failure of decision makers to site facilities in the face of this opposition. Public opposition is often strongest where siting is sought in densely populated areas. These dynamics of siting facilities, rather than the technological issues of siting, are the focus of this section.

1. PUBLIC CONCERNS

Public opposition to siting new facilities centers around six major areas: lack of control over decision making; lack of any perceived benefits; concern over potential health effects; concern over lowered property values; nuisance factors; and inadequacy of environmental standards and enforcement.

a. Lack of Control over Decision Making

If the public is not made an integral part of the siting decision-making process, opposition is nearly assured. Making the public part of the process after the decisions have, in fact, been made, does little more than invite opposition. Giving the public real input into the process may mean that local decision makers must give up some of their decision-making power. As with other decision makers, they can be reluctant to give up this power. As a result, the public often feels a lack of real control over decision making.

b. Lack of any Perceived Benefits

When most people are asked to make decisions on virtually any issue the first question they ask is, "What's in it for me?". Because most people do not accept the responsibility for their own garbage, they do not see any real benefit to allowing the locality to site a waste management facility near them. And, even where they accept some responsibility for their own garbage, they want to have the facility sited near other people whose garbage will be handled by that facility. When this lack of benefit is balanced against concerns about potential health impacts, lowered property values, increased traffic, noise, dirt, etc., it is not surprising that the NIMBY syndrome is so prevalent.

c. Potential Health Risks

Most people readily accept the risks associated with most of our voluntary activities. Driving cars, crossing streets, flying in airplanes, and riding in elevators are good examples. Part of that relates to the perceived benefits and to whether the risk is voluntary or involuntary. Living next to a site to be used as a solid waste management facility is not generally a voluntary activity. Another important factor is how familiar the risk is. Nearly everyone is "used to" assuming the risks of riding in a car, but most of us are not "used to" assuming the risks of a new landfill possible polluting the groundwater or of an incinerator possible polluting the air.

Another factor that weighs heavily is that the public is presented, via the media, with more examples of environmental mismanagement than of effective management. This tends to foster a negative image of waste management facilities. Also, scientific uncertainties make it difficult to provide definitive answers as to whether a facility is safe, and if it is not, to fairly compare the risks to other risks so that the public can make a meaningful comparison.

d. Property Values

The major investment that most people make in their lifetime is their home. Therefore, it is not at all surprising that they will oppose anything that could lower property values. Solid waste facilities and prisons are good examples of facilities that are viewed as potentially lowering property values.

e. Nuisance Factors

Virtually everyone wants to live in a beautiful, quiet and clean neighborhood. Solid waste facilities are basically industrial facilities that bring truck traffic, noise and potential for odors, dust and litter. Because this nuisance factor is visible and constant, it often is at least as important as the "invisible" health concern.

f. Inadequate Environmental Standards and Enforcement

The environmental standards for landfills and incinerators are inadequate at the Federal level and are being revised. It is not clear whether the standards that apply to recycling are adequate. State standards vary. In any event, inadequate standards have led to a lack of confidence by some that these facilities are safe. Some also believe that these standards are not adequately enforced. Press stories of repeat offenders not cleaning up discharges, of garbage on beaches, and of polluted wells reinforce this perception. Enforcement standards whose compliance procedures can take years also tend to undermine confidence in the safety of these facilities.

2. DECISION MAKING

In coping with solid waste decisions, local elected and appointed officials face issues that touch every citizen: higher taxes or fees, expenditures of large sums of money, potential effects on property values, traffic patterns, etc. Decisions on siting can determine whether an official is re-elected. Therefore, local officials are often reluctant to site a facility over the objections of their constituency.

a. Public Participation

As noted above, overcoming the NIMBY syndrome means vesting the citizenry with real input into the process, including the siting process. To have real input the community needs to accept responsibility for its own garbage and understand the options for managing its waste. One of the obstacles to siting is that the community is either not educated on the issues or distrusts the educational effort as an effort to "brainwash" the community.

b. Election Cycle

The local election cycle is normally two to four years. In some communities there is an election every year. During election years there is a tendency to avoid controversial issues. Popular political wisdom is to sidestep taking positions and tell the public what it wants to hear. The amount of time necessary to plan for and implement an integrated waste management system will often exceed the election cycle. The resulting obstacle is that local elected officials can see it in their best interest to not make a decision, rather than run the risk of alientating the electorate by siting a facility over the objections of the constituency.

c. Lack of Dispute Resolution Process

Because of all of these obstacles, the siting of waste management facilities has become increasingly difficult over the years. These forces tend to lead to an impasse rather than a resolution. The lack of a process to resolve siting disputes is a clear obstacle to the siting of waste management facilities.

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OBSTACLES TO MORE EFFECTIVE SOLID WASTE MANAGEMENT

B. FINANCING

1. INTRODUCTION

The financing alternatives for solid waste management systems can range from public ownership and financing, using such vehicles as tax-exempt general obligation bonds or revenue bonds, to complete private ownership and financing. The availability of specific financing approaches is determined primarily by the ownership decision (public versus private), as well as the overall cost and risk of the project. Controlling the financial risk of solid waste management projects can ensure that the project undertaken is successful. Although some types of financial risk apply across the board to all of the various waste management strategies, source reduction, recycling, waste-to-energy projects, and landfilling, each has its unique areas of risk that must be addressed.

2. CONTROLLING FINANCIAL RISK

The principal obstacle in financing integrated solid waste management is managing financial risk. In any financial venture, the risk to investors must be controlled to the point that investors expect a financial return greater than or equal to their financial risk. This balancing of risk and reward is vitally important to the success of integrated solid waste management. Most of the options for improving solid waste management require money from public and private entities as well as individual investors. Therefore, to attract and retain financial resources for carrying out a new activity, like running a recycling center, the financial risk of the activity must be controlled.

The economic viability of a project will be based on an evaluation of whether project revenues will satisfactorily cover the full cost of the project, including all expenditures for planning, construction, operation and maintenance, debt service, and closure and post-closure. Even projects that will be financed entirely through general obligation bonds should be subject to some assessment of their risks in order to control costs.

Risk enters into both revenue and cost calculations. Some of the major factors that contribute to the risk attached to a public or private project include: the technical viability of the project; completion schedules; project operation; the probability of being issued and keeping a permit; legislative or regulatory changes; a steady supply of solid waste; potential environmental damages; and the sale of any recovered products. The risk associated with each of these factors can be allocated to the party with the greatest control over that factor or to the party that will benefit most from the successful completion of the project. The allocation scheme will vary based on ownership and the financing structure.

On the revenue side, risks can be managed through guaranteed tipping fees, subsidies, and the development of agreements that guarantee the supply of waste up front (e.g., a put or pay arrangement). These risks are generally allocated to the municipality. Similar agreements can also be structured for the back end to ensure demand for the recovered products (e.g., energy sales contracts with publicly owned utilities under Public Utilities Regulatory Power Act (PURPA), contracts for recycled materials, etc.). Market issues are discussed in section D of this chapter.

Project developers can also allocate to participants the risks associated with the cost side of the equation. In a privately financed operation, for instance, the vendor typically assumes the risk for the completion schedule, project operation, and the performance of the technology. It may be difficult, however, to control some of these risks. As an example, waste-to-energy facilities are currently facing significant delays in construction because of environmental concerns related to the safe disposal of ash.

3. RISK AS AN OBSTACLE TO SOLID WASTE MANAGEMENT PROJECTS

Financial risk has specific implications for the various types of solid waste management projects.

a. Source Reduction

Financial risk is not a major issue for corporations that want or have an incentive to manufacture products, which, at the end of their useful life, result in less waste or waste of lower toxicity. The principal challenge to these firms is the development of a market for these products. Market and other barriers to source reduction are discussed elsewhere in this chapter.

b. Recycling

The capital requirements for recycling facilities are generally lower than those for waste-to-energy plants or landfills, and therefore these businesses present enormous small business opportunities. However, there are also significant risks that can create financing problems. On the revenue side, for example, recycling centers need a steady supply of recyclable materials, as well as stable demand in the end markets. Agreements can be structured to ensure the flow of materials to the recycling unit. For example, the operation can be linked to the municipal collection program. It may be more difficult to arrange for similar agreements on the back end because of the considerable volatility in the demand and prices for recycled goods, especially for products like paper.

Two other sources of risk identified by communities contemplating recycling centers are liability insurance and siting difficulties.

c. Waste-To-Energy Projects

The financing of waste-to-energy operations, like that of recycling centers, hinges on controlling project risk. In addition to coping with siting and permitting risks, waste-to-energy projects need to establish contracts to ensure (1) the supply of incoming solid waste, and (2) the back-end sales of the energy. In the past, these and other risks have been successfully managed, although siting and permitting problems are becoming more difficult to address. It is unclear to what extent these problems may have hindered the development of more projects in the past.

d. Landfilling

As with resource recovery, there are adequate vehicles (e.g., bond issues) for financing construction of a landfill. A far more critical element of landfill development is the issue of siting, which can delay and even permanently postpone construction of a landfill. Once a landfill is operating, the major risk is from liability for environmental damage. To minimize these risks, owners may seek insurance or collect separate funds to be set aside to pay for future contingencies. This type of risk is inherently linked to the design, construction, and operation of the landfill.

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OBSTACLES TO MORE EFFECTIVE SOLID WASTE MANAGEMENT

C. INSTITUTIONAL OBSTACLES

Solid waste management, for the most part, is accomplished by State and local governments. The private sector can, and increasingly does, supply key pieces of the MSW management system from collection services to recycling centers, landfills, and combustion facilities. However, the responsibility for planning and implementing MSW management systems lies with local governments (with State oversight), regardless of whether the system components are publicly or privately owned and/or operated.

Institutional barriers to improved solid waste management exist at both the State and local levels. These obstacles are in the areas of: State and local government authority (including State solid waste management planning, waste flow controls, enforcement authority, and funding), multijurisdictional projects, local public bidding practices, preferences for "black-box-type" solutions, and liability issues. Although some States and local governments are addressing these institutional obstacles, others have yet to begin. Another serious obstacle not discussed in detail in this chapter is the acceptance of the throwaway ethic by public, and public officials (including elected officials and public works engineers). Sound solid waste management and the conservation of resources demand a solution to this obstacle. In an an attempt to address these problems, a growing number of communities are seeking to restrict certain types of products or packaging (Berkeley, CA and Suffolk County, NY, for example). Expanded polystyrene packaging is frequently targeted because of concern about the effect of chlorofluorocarbons on the ozone layer. Reducing the overall amount of plastic in the waste stream may be a side effect rather than the primary intent of such regulations. However, effective source reduction is best accomplished at the national level.

1. STATE AND LOCAL GOVERNMENT AUTHORITY

Local government officials tend to put off tackling solid waste management issues far enough in advance to avoid a crisis. Several years of planning are needed to develop appropriate management systems; and the construction of landfills, recycling centers, and combustion facilities also takes time. An impending capacity crisis is often needed to set the planning process in motion. Communities that have adequate disposal capacity (generally landfill space) may not be motivated to undertake alternative management approaches such as recycling projects. Several specific obstacles support the inertia of the "do nothing" attitude.

a. Lack of State Planning

According to Subtitle D of RCRA, each state is to develop a State Solid Waste Management Plan. Such plans are needed to ensure adequate disposal capacity within the State, to allow local jurisdictions to enact local flow control ordinances, to encourage markets for energy and recovered materials, and so forth. About half the States have developed plans and had them approved by EPA. However, some State agencies have been hampered in their efforts to develop a Solid Waste Management Plan by the lack of State enabling legislation. No Federal incentives for State plan development currently exist, nor are there sanctions for the lack of a plan.

b. Waste Flow Control

New solid waste management facilities are designed to handle a specific fraction of the MSW stream over a set period of time. Should the waste flow change radically from the original plan--either too much or too little--the economics and capacity of the facility can be adversely affected. Landfills can provide day-to-day flexibility in receiving a shifting waste flow, but they may fill up more rapidly than planned. Too low a flow may not provide the revenues to cover operating and fixed capital costs unless the tipping fee increases; and increasing the tipping fee can further discourage increases in flow. Recycling and waste-to-energy facilities depend on the sale of recovered energy and/or materials for a significant portion of facility revenues. Shortfalls in the waste flow can raise tipping fees or force the facility to close down.

Some of the factors that cause upsets in waste flow projections include the failure to plan recycling activities as an integral part of the overall solid waste management scheme, competition from lower-cost disposal facilities (such as a nearby landfill with a low tipping fee), the direction of waste to an inadequate facility by an outside authority such as a State, unanticipated population increases, or, as has happened in some communities, illegal pickup of curbside recyclables by scavengers.

Local governments need to have State enabling legislation in order to develop flow control ordinances. Waste flow can also be directed by local licensing procedures for private haulers and recycling collection firms.

c. Costs

Traditionally, governments have not made citizens pay the real costs of waste disposal, particularly in the case of landfills. Often, the costs of waste management are hidden in State and local property taxes and are not directly related to the amount of waste that residents generate. This lack of direct cost association prevents citizens from taking more responsibility for waste reduction, and can cause public resistance to the development of new solid waste management facilities. The cost increases that state-of-the-art landfills and waste-to-energy facilities represent may also conflict with local jurisdiction budget constraints and tax increase restrictions such as Proposition 13 in California. Special fees can generate political opposition or outright avoidance. For example, as the solid waste fees increased in some areas of the Northeast, roadside and vacant lot dumping also increased.

2. MULTIJURISDICTIONAL PROJECTS

A technical analysis may indicate that a multiple jurisdiction project is the most effective solution to the solid waste problem. However, this approach can introduce new obstacles to implementation.

a. Mutual Suspicion

Local jurisdictions often have a history in which each believes that its neighbor has not played fair in the past. These perceptions color new efforts at cooperation, sometimes making common interest unattainable.

b. Equity

Even in multijurisdictional efforts where there is no mutual suspicion, the obstacles are large. Primarily, they center around the equitable sharing of risks, costs, and benefits. For example, if one jurisdiction is the host community for a facility, what constitutes equitable sharing for the other jurisdictions? Can the host community be compensated adequately? Compensation alternatives do exist, including reduced or tipping fees for host community residents, cash payments, or the construction of local improvement projects. However, negotiation of such agreements can be difficult; approval by each participating jurisdiction is sometimes impossible.

3. LOCAL PUBLIC BIDDING

Most States have public bidding laws that constrain local government purchasing. Because solid waste management is complex, there are now specialized firms capable of providing the technology for solid waste management. These firms provide services that include design, construction, operation, and maintenance of facilities, as well as marketing of recovered materials and energy.

a. Procurement Process

Rather than issuing a procurement using an integrated service approach (e.g., a combination of recycling, waste-to-energy, landfill), local governments generally break a procurement into discrete packages. Each package is then bid separately. A public works project will typically have a design and engineering package, a construction package, and sometimes an operational package for each of the waste management options. Bidders on one package may be excluded from bidding on others. This precludes vendors who are fully capable of integrating waste management techniques from participating and eliminates those who offer a full-service approach to waste-to-energy or recycling facilities. In many cases, operational services are performed by the public body. Some firms will not bid when public operation is contemplated because of a lack of control over quality assurance.

b. Low Bid

Local public bidding laws typically allow the jurisdiction to set minimum standards for bidders. These can be technical specifications or qualifications. The procurement is then awarded to the qualified bidder with the lowest price. Because many public agencies depend on private entities for solid waste collection, recycling, and disposal (whether by means of waste-to-energy and landfill or by landfill only), the bidding process calls for broader contractor and proposal selection criteria, including such factors as the technical and financial reliability of the contractor as well as its willingness to negotiate risk sharing and associated costs.

4. PREFERENCE FOR SINGLE SOLUTIONS

Perhaps as a result of society's acceptance of the throwaway ethic, local decision makers most often look first and most intently at solid waste management options that are promoted as single solutions, yet total waste management solutions. Historically, landfilling was first seen as the only solution necessary. If a landfill site could be found, then there would be no need for further waste management planning, and citizens could continue their existing waste habits. More recently, the mass burning of waste has been viewed by some as "the" solution.

Integrated waste management requires decision makers to develop more elaborate, multiple solutions including recycling and combustion in addition to landfills. Management options such as recycling require changes in the way that citizens handle their waste. Recycling is also not as controllable a management option as landfilling or incineration, in the sense that recycling markets fluctuate depending on factors over which the waste management facility largely has no control.

5. LIABILITY ISSUES

Another institutional obstacle is the pervasive legal-environmental liabilities that confront recyclers. These include strict liability for any release of hazardous substances to the environment under Superfund, and a system of hazardous waste regulations under RCRA that regulates secondary-based producers (e.g., secondary lead smelters) but not their primary-based competitors.

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OBSTACLES TO MORE EFFECTIVE SOLID WASTE MANAGEMENT

D. MARKETS

1. OVERVIEW

Markets are perhaps the greatest obstacle to the solid waste management alternatives of recycling, composting, energy recovery, and landfill gas recovery. At the same time, markets represent the greatest opportunity in these areas. If recovered materials, energy, or fuel from MSW cannot be utilized in a recycling or energy application, then the recovered materials, energy, or fuel will be disposed of in a landfill or incinerator.

For the purposes of this section, a market is defined as utilization of a recovered material or energy product. This utilization does not necessarily imply that the product has a dollar value. For example, a leaf compost can be usefully applied as a soil enhancement, but may be given away. The market system also operates through a supply/demand/price relationship, although a zero or negative price does not necessarily lead to unlimited demand.

2. MARKETS FOR RECOVERED MATERIALS

The materials commonly recovered from MSW for recycling are: various grades of waste paper; ferrous metals; aluminum such as cans; glass containers; plastics such as milt bottle or PET soft drink containers; leaves and/or grass clippings for compost; tires for retreading or energy recovery; lead acid batteries, and used oil. The recycling market may or may not be in the same product. For example, old newspapers are recovered for use in deinked newsprint, in recycled paperboard, in paper construction products, in cellulosic insulation, in molded pulp products, in animal bedding, and in special mulches. Each market has a limit to the demand for old newspapers. PET beverage containers that are recycled are used for fiberfill, strapping, and other nonfood applications.

The recovered materials market barriers may be classified as economic and noneconomic.

a. Economic Barriers

There are nine generic market barriers to increasing materials recycling.

(1) The cost of recovery, collection, and processing compared to the value of the material to a recycling plant or mill. In a competitive market, the cost of recovering and preparing the materials in MSW can often exceed the value of the material in the marketplace, even if the avoided disposal cost is considered. Some materials may be profitable to recover only at the peak of their price cycle. Otherwise they will have to be subsidized by the solid waste management system and/or by volunteer labor to collect and process them.

(2) The cost of transportation to the user. The market price for some materials is based on delivery to the point of consumption. If the cost of transportation is high because of the distance or because of the mode of transportation, the material may be unprofitable at the point of recovery. For example, glass cullet may be unprofitable when shipped long distances.

(3) Recovery of consistent quantities and quality of recovered materials. Most manufacturers, e.g., paper mills, depend on a predictable flow of materials meeting their specifications. An MSW processing facility may not be able to

meet the requirements of a specific recycler because of low volumes or inconsistent quality. This then makes them a less desirable source.

(4) Lack of knowledge by the recovering agency of how secondary materials markets operate. Information on who the buyers and sellers are in the marketplace, and how to develop arrangements with them is often lacking. For example, a municipality with a newspaper collection program might deal with one or more of: brokers, waste paper dealers/packers, paper mills, and exporters, or a producer of cellulose insulation.

(5) Lack of opportunities for new businesses. The addition of a materials recovery activity may lead to the need for new or expanded (private) businesses to recover, process, and market materials. Many of these businesses are ill-suited to survive in a marketplace that displays price fluctuations, marginal economics, and limited opportunity to establish its niche in a competitive secondary materials marketplace.

(6) Recycled materials may not be cost competitive. At the recycling end of the business, there is often a difference in the cost of producing a product made wholly or partly of recycled materials and one made of virgin materials.

For example, producers of recycled printing and writing paper utilize "market (wood) pulp" and pulp substitute grades of waste paper. They usually have market niches for low-volume specialized products such as book papers. They are not cost competitive with high-volume, low-cost "commodity" grades of paper, e.g., copier paper and form bond. The production of aluminum is very energy intensive, making reprocessing cost effective. With raw materials costs increasing and/or with the increase in disposal costs, recovered aluminum is cost competitive with virgin materials. The aluminum beverage can is the most notable example.

(7) Price fluctuations. Materials entering markets for recycling will behave much like other commodities. Thus, there are historic cycles of price swings. For example, corrugated paperboard might sell at or above $110 per ton at the peak of its cycle and as low as $20 per ton at the bottom of its cycle. These changes can take place rapidly, with the market stabilizing in between.

(8) Quality control of recovered materials. An objective of recovery from MSW is to reduce the quantity needing disposal. Thus, quality control is not as strong an incentive as in MSW quantity reduction. Also citizens or businesses may be unable, unwilling, or lack the knowledge to exercise proper quality control at the source. For example, magazines put with old newspapers will likely have to be removed before the old newspapers can be recycled.

(9) In the past, freight rates have been identified as an inhibitor to the transport of scrap. Studies in the 1970's identified small freight differentials favoring virgin materials. However, with deregulation of the trucking and rail industries imminent, this problem appears to be diminishing.

b. Noneconomic Barriers

There are also generic noneconomic market barriers to increased recycled material or products.

(1) Industrial barriers at plants or mills. The use of recycled materials can be integrated into some virgin materials product manufacturing operations. However, many plant managers and operators may perceive secondary materials to be disruptive, technically difficult, and disturbing to a smoothly run operation. This creates a resistance to change unless a

significant economic incentive exists.

(2) The ultimate user's willingness to purchase a product or material with recycled material content will create markets. However, the end user may reject such a purchase. The reasons can vary from tradition to concerns over product specifications or product image, or other noneconomic reasons.

An end user may perceive that a recycled product is not functionally equivalent to or as attractive as one made of virgin materials. Or, an end user may perceive a risk in using recycled materials when there is no obvious reward in his marketplace for doing so. Finally, the end user may have direct or indirect ties to a certain supplier. For example, many newspaper publishers have ownership interests in newsprint mills or long-term relationships to multiple suppliers.

This barrier may be the most difficult of all if the recycled product is not a total match in all ways and indistinguishable from the virgin materials counterpart. Even government and private agencies that purchase recycled materials and products have found that customer attitudes and public perceptions wax and wane.

(3) Restrictive specifications or rules. Some agencies have strict unchangeable specifications that forbid the use of recycled materials. Although sound technical and economic reasons for the restrictions may exist, these may relate more to traditional practices and perception of risk and reward. For example, an auto maker may specify a lubricating oil form a refined crude oil product and simply prohibit the use of a re-refined oil because of the perceived risk of contaminants in the oil.

(4) Time required to build infrastructure. The recovery,

collection, and processing infrastructure and the utilizing plant or mill infrastructure take time to put in place. Usually it takes two to three years to expand an existing plant or build a new one after the decision to proceed. In addition, the recycling industry may introduce delays to ensure an adequate supply of raw materials and confirm that the ultimate user is indeed a long-term market before committing to the capital investment. In the meantime, virgin materials production capacity may pre-empt the market. By contrast, community collection programs can come on-line in a short period and overwhelm a market temporarily. Also, scrap processors are generally able to increase throughput in a short period of time.

(5) Product liability to end user. Most manufacturers today are very cautious about any step that could make them more vulnerable to a product liability charge because the product failed or did not meet product specifications. In many cases, they perceive the risk of contamination or other unwanted features of a recovered material to be far greater than the reward of lower cost or environmental "good citizenship." The example of re-refined oil given above would fall in this category.

(6) Flow control laws for waste-to-energy projects have been restrictive in the past, especially on the recovery of paper for recycling. More recently this has not been a significant issue, but it is still of concern.

(7) As municipal governments become more actively involved in selling recovered materials, they may need to do so through private contractors and/or nonprofit corporations. Regulations on disposal of property are often very cumbersome.

The market barriers to recovered materials can be very difficult to overcome, even though the materials recovered may be in common usage and in well-established markets. Thus, market expansion--the objective at issue--can present major challenges.

3. MARKETS FOR RECOVERED ENERGY AND FUEL

Energy recovered from MSW takes the form of electricity, steam, or fuel, e.g., refuse-derived fuel. Each has specific market barriers. It is unusual for the energy value of MSW to cover full costs without a tipping fee for disposal of the MSW.

a. Electricity

Public and private utilities prefer to generate electricity and sell it. Thus, they have generally resisted buying electricity from outside generators such as waste-to-energy plant owners. Two issues are paramount to utilities when considering the purchase of electricity from waste-to-energy plants: the price to be paid by the utility and the displacement of capacity available from other traditional (fossil or nuclear) fuel sources.

The Public Utilities Regulatory Policy Act (PURPA) is intended to make the rules very clear. In practice, however, PURPA has been more successfully applied in some States than in others. Some utilities have been pursuing changes in the PURPA regulations that could be detrimental to waste-to-energy projects. Most large waste-to-energy plants in operation, under construction, or in planning will market electricity to the local power utility, which is obliged to buy under PURPA regulations. The rate received from the utility is often not high enough to ensure cost competitiveness with a landfill in the near term. Other factors also come into play such as local disposal options and State utility laws.

b. Steam

The markets for steam are industrial process steam and heating/cooling steam for institutions, steam loops, and the like. IN general, barriers to the production of steam include: the steam markets must be relatively close to the MSW plant; must have a year-round demand; and must be able to contract for a long period. In addition, a waste-to-energy plant must be able to provide the steam at pressures and temperatures acceptable to the market. There is no size limitation for marketing steam, but plants above 1,000 tons per day are usually selling to an electricity market.

c. Refuse-derived Fuel (RDF)

RDF is a fuel that can be burned in a dedicated boiler to produce steam or electricity or marketed to retrofitted boilers for burning with a fossil fuel for the same purposes.

Some RDF systems are equipped with digestors to product compost. Most recover materials in a front-end processing system. The market barriers for generating electricity or steam from RDF are essentially the same as discussed above. RDF marketed as a fuel presents even greater difficulties. For example, retrofitted boilers not designed for RDF may experience operational difficulties when burning RDF. Thus, markets for RDF have been very difficult to establish, except for dedicated boilers producing steam or electricity.

There is some potential to recognize another form of solid fuel other than RDF, namely a monofuel such as chipped tires, waste wood, or nonrecyclable paper. At present, the wood products and paper manufacturing industries have solid fuel boilers that can sometimes utilize this type of solid fuel without system modification.

Perhaps the most significant market barrier for all of the energy alternatives is the absence of an identifiable enthusiastic market for steam or electricity based solely on MSW as fuel. Ideally, users of fossil fuels would be sold MSW-derived energy rather than buying more readily available fuel or energy. Fuel in any form is a commodity and, therefore, is bought on the basis of energy content for the particular type of energy production facility.

d. Methane from Landfills

All landfills produce methane gas by means of the anaerobic degradation of organic materials. A number of gas recovery operations are in operation in the United States. However, market obstacles exist to the use of methane from landfills. They are:

(1) Landfills equipped for methane recovery need to be large, with degradation taking place rapidly enough to produce enough volume to be marketable.

(2) The methane is usually corrosive and contains gases that lower the Btu content. THerefore, they need to be "cleaned up" or blended in minute quantities with "normal" methane.

(3) The landfill must be close to its market, which could be a plant using methane as fuel or a natural gas pipeline. Either way, proximity to the market is extremely important.

At least one landfill, Puente Hills in los Angeles County CA, generates and utilizes electricity from recovered gas on site. Thus, the market barriers do not exist in this case.

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OBSTACLES TO MORE EFFECTIVE SOLID WASTE MANAGEMENT

E. EXISTING INDUSTRIAL INFRASTRUCTURE

1. STRUCTURE OF MANUFACTURING INDUSTRIES

Most of the industries that could use recovered materials obtain their principal raw materials from virgin raw materials sources. Typically, a large segment of these industries is integrated from raw materials to manufacturing and even to distribution at the retail level. Thus, economic and technological ties link these industries to virgin raw materials. Manufacturing operations are typically located close to the source of raw materials, and often far from densely-populated areas generating large quantities of recoverable MSW. Other industries, although close to densely-populated areas, may be clustered in one or two geographic regions and thus may be equally inaccessible to other large MSW-generating areas.

The economic realities of geography and location of the manufacturing capacity of an industry may, in fact, determine the basic design of an integrated solid waste management system. If the manufacturing capacity is located in foreign lands, then the seacoast population centers become the suppliers of waste materials.

Several industries also use large amounts of scrap materials, which are derived from industrial scrap. A significant portion, however, also use postconsumer waste in relatively large quantities, most notably paper mills, glass container plants, aluminum smelters, and steel mills and foundries.

2. OBSTACLES TO SOURCE REDUCTION

Firms will adopt source reduction practices if they result in a decrease in manufacturing costs and higher profits. For example, a producer can increase the profitability of a new product by reducing its packaging (and thereby reducing costs) once the product has established a market share. The same is true for the product itself. Therefore, a strong economic incentive exists for the manufacturer to reduce costs with package redesign or product redesign as long as demand for the product is not adversely affected, or if demand increases. The profitability of most source reduction processes or product changes is uncertain, however. This is particularly true for changes that increase product quality and/or durability without a compensating increase in its price.

Industries face different types of problems when they attempt to reduce toxicity through source reduction. Reducing the toxicity of materials or product contents may be very difficult because of the unique characteristics or advantages of the toxic material. For example, cadmium gives certain characteristics to metal parts that may be difficult to duplicate with nontoxic substitutes.

3. ECONOMIC OBSTACLES TO INCREASED RECYCLING

The industrial infrastructure may inhibit the ability of the industry to accommodate increased use of recovered postconsumer wastes. The principal economic obstacles to increased recycling of postconsumer waste materials as they relate to industry structure are as follows:

1. The supply of recyclable materials may be unstable in quantity and quality.

2. The supply of a waste material may be seasonally out of phase with the demand for the material. For example, the need for corrugated boxes is high in the summer and fall when holiday season shipments are made; the supply of old corrugated boxes does not increase until after the holiday season.

3. The geographic location of the recycling materials capacity compared to the geographic location of the postconsumer recyclable materials may be unfavorable.

4. Adding a recycling capacity to an existing virgin materials capacity may be technically and economically infeasible. An adequate supply (availability) of acceptable quality recyclable material may also be a barrier.

5. Adding to an existing recycling capacity or expanding it independently of the virgin materials sector(s) of the industry may also be technically and economically infeasible.

6. The time required to phase in a recycling capacity and to build the waste materials supply system (which is about the same as for virgin capacity) slows the process.

7. Establishing a recycling operation for a different end use than the original use of the postconsumer recovered material may not be feasible. For example, producing fiberfill from PET bottles means that the PET bottles are entering a use that is much different from their original purpose, and the supply/demand balance could be very difficult to achieve. The same is true of paper products such as old newspapers used to produce cellulosic insulation.

8. The procurement practice of end users to support a restructuring or partial restructuring of an existing industry to produce more materials or products with a recycled materials content may be a barrier, especially when the recycled product is perceived to be inferior to its virgin materials counterpart.

9. The capital requirements to restructure must be met.

10. Federal and State guidelines that would permit routine handling of nonhazardous industrial wastes for on- or off-site disposal are lacking. Industrial process wastes are often all treated the same and may have more disposal restrictions than other wastes.

11. Because there is no fully developed distribution system for recovered materials, an effective system to transport waste materials from the point of recovery to the point of use does not exist.

12. The recycling industry has little or no control over the nature of the product when it is manufactured; thus, the existing industry infrastructure might produce products that are difficult to recycle.

4. OBSTACLES TO ENERGY RECOVERY

In much the same context as described for recycling, the industrial infrastructures of power generation and steam use are tied to fossil fuels and to integrated energy production plants. Energy production is carried out by utilities that have no ties to solid waste management. Special fuels such as wood wastes, tires, and low-grade waste paper may find industrial applications independent of utilities. For example, the paper industry and wood products industry both derive energy from nonconventional solid fuels such as wood wastes.

The principal obstacles to increased recovery of energy from MSW as they relate to existing industrial infrastructure are as follows:

1. The principal purpose of waste-to-energy is solid waste management, and not the energy derived from the wastes burned; thus, there is a difference in the principal objectives of the two systems.

2. The high capital investment per ton of capacity required to build a waste-to-energy plant must be met.

3. The time and effort required to go from planning to operation of a plant are costly.

4. Where there is already adequate capacity to produce electricity and/or steam from fossil fuels, there is a resistance by the utility industry to integrating the products of waste-to-energy into the existing system.

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OBSTACLES TO MORE EFFECTIVE SOLID WASTE MANAGEMENT

F. IMPLICATIONS OF FEDERAL, STATE, AND LOCAL TAX CODES

1. INTRODUCTION

Historically, Federal, State, and local governments have structured their tax codes to encourage economic activity in numerous areas. At the Federal level, for example, tax incentives have been used to achieve broadly defined objectives, such as stimulating capital investment, as well as more narrowly focused goals, such as increasing production of specific natural resources. Several recent (pre-1987) Federal tax incentive packages have affected integrated solid waste management. In addition, some major tax incentives and disincentives are currently provided under the Federal and State and local tax codes.

2. RECENT EXAMPLES

Before enactment of the Tax Reform Act of 1986, the Federal tax code provided for numerous tax incentives aimed at stimulating capital investment. These included the investment tax credit, the accelerated depreciation schedule, and the preferential treatment of capital gains. The Federal tax code also allowed tax-exempt financing--using such financing vehicles as industrial development bonds and pollution control bonds (repealed after 1984)--for a wide range of projects deemed beneficial to the public. All of these incentives had a positive impact on development of solid waste management systems, such as resource recovery facilities, that are capital intensive.

The Federal tax code also provided disincentives, especially for recycling, by encouraging virgin material production of oil, gas, and approximately 100 different minerals through depletion allowances, as well as timber through capital gains allowances.[1] Depletion allowances are tax deductions--specified as fixed percentages for each industry--that are similar in concept to depreciation schedules. However, there is an important difference between depreciation and depletion. Whereas only the original capital investment can be depreciated, depletion allowances can be used against all income resulting from a mine or well. Depletion is also based on the current value of an asset, rather than the original investment, so the tax deduction can be much larger using depletion.

The tax advantages afforded the timber industry consisted primarily of allowing tree-planting costs to be written off, rather than treated as capital investments. Although no longer allowed under the current Federal tax code, the preferential tax treatment previously provided the timber industry appeared to have a significant negative impact on the paper recycling industry, as discussed below.[2]

By encouraging virgin material production, depletion allowances, and capital allowances for the timber industry, may have worked against recycling. Specifically, these tax incentives may have resulted in lowering the cost of virgin material inputs compared to secondary materials. These low-cost virgin materials may have displaced such commonly recycled products as paper (timber), used oil (crude oil), cans (ferrous and nonferrous metals, bauxite), and glass (silica soda ash, sand, limestone, and natural gas used to fire the glass-melting furnaces).

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[1] Franklin Associates, Ltd., for the Illinois Department of Energy and Natural Resources, "Feasibility of Tax Incentives for Purchases of Recycling Equipment or Recycled Products," ILENR/RE-EA-87/06, November 1987.

[2] Franklin Associates, Ltd., 1987.

3. CURRENT FEDERAL TAX INCENTIVES

a. Disincentives

The Federal tax code was completely revamped under the Tax Reform Act of 1986. The net result left very few tax incentives for integrated solid waste management. First, the Reform Act repealed the investment tax credit, the accelerated depreciation schedule, and preferential treatment of capital gains. The loss of these incentives makes solid waste management ventures less attractive to private investors. Second, the Reform Act also restricted the use of tax-exempt financing by (1) reducing its availability through lower state caps on private activity bonds used for privately-owned projects and (2) eliminating tax-exempt bonds for high issuance cost projects (those with issuance costs greater than 2 percent of the issue) and "non-qualifying" parts of a project. Third, the depletion allowances for some virgin materials were retained with modifications. However, as discussed below, the retention of depletion allowances may be less of an impediment for recycling than originally envisioned.

A preliminary literature search did not reveal any studies that explored the extent to which recycling has been hampered by the existence of depletion allowances. However, anecdotal information collected through conversations with various trade associations suggests that depletion allowances--which are still permitted under the current tax code--may not have a significant adverse impact on recycling.

The potential impact of depletion allowances can be examined by focusing, on two virgin materials used in products that are frequently recycled: oil and gas (used oil, plastics, glass) and bauxite (aluminum). It is important to note that there are no depletion allowances for the timber industry, and the planting cost writeoff previously provided to the timber industry was repealed by the Tax Reform Act of 1986. Thus, the timber industry no longer appears to have an advantage over recycling in the marketplace. Our preliminary findings for the oil and gas and bauxite industries are summarized below.

(1) Oil and Gas

Depletion allowances (set at 15 percent for the oil and gas industry) are available only for independent oil and gas producers. The independent producers in the lower 48 states (there are very few independents in Alaska) account for approximately 30 percent of the total oil and gas consumed nationwide.[3] Prior to the Reform Act, many of these independent producers qualified for depletion allowances; however, far fewer are now allowed to take depletion allowances because of the alternative minimum tax payment schedule established by the Reform Act.

In order to determine whether it can claim depletion allowances, a company must estimate its taxes as it normally would, and estimate an alternative minimum tax. If the alternative minimum tax is larger, the firm must pay this amount. If, on the other hand, the standard tax figure is higher, the firm can pay this amount, factoring in various deductions, such as depletion allowances. It is currently estimated that between 25 to 40 percent of all independent producers (contributing only 8 to 12 percent of the total oil and gas consumed nationwide) pay the standard tax rather than the alternative minimum tax. However, the percentage of these independent producers that can actually take depletion allowances (and, accordingly, the percentage of oil and gas affected by depletion allowances) is probably much smaller because of additional qualifying criteria imposed by the Reform Act, such as limits on daily production and annual sales.

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[3] Pasher, Bryan, Independent Petroleum Association of America. Personal communication.

It appears that depletion allowances affect only a very small percentage of the oil and gas that is produced nationwide. Thus, it would be difficult to conclude that depletion allowances have interfered with the overall recycling of oil- and gas-based products, such as plastics and used oil, or other recyclables whose manufacturing processes use oil and gas.[4] For this sector, and possibly for others, a strategy that attempts to repeal the depletion allowances would do little to encourage recycling.

(2) Bauxite

Depletion allowances (currently set at 22 percent for bauxite) are available to all aluminum manufacturers that mine bauxite, and they are commonly used. In contrast to oil and gas producers, bauxite producers do not appear to be limited in their usage of depletion allowances based on annual revenues or daily production rates. However, the Reform Act does constrain the extent to which depletion allowances can be used for all industries (e.g., up to 50 percent of the taxable property income).[5]

There was no readily available information on the dollar amount of the depletion allowances used by the aluminum industry. Thus, it is difficult to assess the impact of depletion allowances on the recycling of aluminum. It is interesting to observe, nonetheless, that some of the largest aluminum manufacturers have established recycling centers. Thus, there is some question as to whether depletion allowances have damaged recycling opportunities in the case of aluminum cans.

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[4] It is important to note that although this summary represents the current tax situation for oil and gas, the Department of Energy is also proposing options that would provide for additional tax incentives for small oil producers under the Energy Security Act (See: Department of Energy, Energy Security: A Report to the President of the United States, March 1987.

[5] Cheely, Edgar, ALCOA. Personal communication, May 26, 1988.

b. Incentives

On a more positive note, the tax code changes did remove the State caps on private activity bonds for municipally-owned projects, as well as the capital gains allowances for the timber industry. Also, it is important to recall that tax incentives are not the only agents influencing integrated solid waste management. Federal regulations can also have enormous impacts on the demand for resource recovery facilities and recycling. The best example of this is the Public Utility Regulatory Power Act (PURPA), which requires utilities to purchase alternatively produced energy at avoided cost (interpreted as the cost of building another power plant or, if the utility has excess capacity, the cost of operating at higher capacity). PURPA has thus stimulated the construction of alternative energy sources (e.g., resource recovery facilities, cogeneration and hydroelectric plants, and wind farms) by guaranteeing a market and a fair price for the energy produced on the back end. It has, in effect, controlled project risk. Various EPA regulations may also encourage recycling and source reduction.

4. CURRENT STATE AND LOCAL TAX INCENTIVES

Like the Federal government, State and local governments have also structured their tax codes to spur investments in specific areas. With respect to integrated solid waste management, especially recycling facilities, many State and local governments have already initiated tax incentives including:

waiving sales taxes for the purchase of recycling equipment; exempting the recycling facility from property taxes; and establishing investment tax credits and accelerated depreciation for recycling equipment.[6]

Again, there are also non-tax incentives that can stimulate integrated solid waste management projects. Some States use tipping fees to create funds to subsidize recycling centers. Others, such as the State of Massachusetts, stipulate the purchase of recycled products in their procurement guidelines.

Although tax incentives are common at the State and local level, it is not clear how cost effective these incentives are. First, State and local taxes generally represent a very small percentage of total operating expenses, especially after all deductions are considered. Thus, providing State and local tax incentives may not provide enough monetary inducement to change strategic business decisions. Second, tax incentives may be used to increase profits, rather than to reduce the cost of the recycled product.[7] Finally, tax incentives do not always directly address the issue of project risk, which continues to be a key concern to integrated solid waste management.

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[6] Franklin Associates, Ltd., 1987. This document provides a good overview of tax and non-tax incentives for recycling facilities in selected states.

[7] Franklin Associates, Ltd., 1987.

CHAPTER 3

OBSTACLES TO MORE EFFECTIVE SOLID WASTE MANAGEMENT

G. INFORMATION

Information barriers are a component of several other obstacles discussed in this chapter. In each of these cases the control and flow of information affects the outcome of decisions about how to manage solid waste. For example, siting problems involve communicating information about costs, risks, and alternatives to decision makers and citizens. The effectiveness of this communication may determine the outcome of the decision, regardless of the relative economics of alternatives. Similarly, information plays a role in financing and in the successful establishment and operation of markets for scrap materials.

The theoretical importance of information in making policy decisions is well known. Less apparent is how this barrier relates to solid waste issues.

1. IMPORTANCE OF INFORMATION

The major implication of poor or incomplete information is that policy makers will misallocate resources. When consumers purchase goods and services, they do not always have perfect information: for this reason, two neighboring retailers can sell the same product for different prices. If consumers could tap into a universal database of prices, the market would "work" much better and dealers would have to meet the lowest price or lose customers. The reason that this information is not available is the cost of collecting and maintaining it. In some cases, however, the public or private sector is motivated to collect information.

The provider of the information will depend on the particular situation. Governments often collect information on major issues when an "impartial" source is desirable such as in setting health standards. Government may also collect data that are too expensive for individuals to collect or that provide a collective value larger than could be derived if individuals compiled the data themselves. Examples of this include the census; data on employment, prices, and economic trends; and technical reports on subjects ranging from agriculture to environmental controls. Private sector firms and nonprofit organizations may also collect and distribute information.

2. SOLID WASTE EXAMPLES: LACK OF INFORMATION

Like all markets, the markets for products and services related to waste management require information in order to function properly. Lack of information restricts the operation of these markets and therefore leads to ineffective solid waste management in three ways: in the assessment of products and their solid waste consequences; in the options available for solid waste management; and in the comparison of those waste management options.

a. Product Choice

Consumers are rarely aware of the solid waste implications of their buying habits; they do not generally base their purchases on considerations of disposal costs, recyclability, or tradeoffs between waste generation and source reduction. Consumers can get access to information about the performance of products they buy: how long it should last (e.g., the length of the warranty), the maintenance requirements, and the price. Some of these are easier to obtain than others, and sometimes consumers pay a premium for this information, such as subscription to Consumer Reports or a service agreement. Information on the impact of a product on the solid waste stream, however, is neither available to nor considered by most consumers.

When energy prices rose in the 1970's, consumers became acutely aware of their energy consumption. Utility bills and gasoline pumps provided consumers with direct information on the cost of their comfort and driving habits. Information on costs and impacts of the wastes they generate is often hidden from consumers: there is no meter on garbage trucks. Now, as solid waste disposal prices increase, information about the impact of products on the solid waste stream may follow.

The same information barrier applies to producers. The demand for goods that drives their production is not strongly affected by solid waste concerns. Because producers do not directly pay the costs for disposing of their products, their production decisions do not consider the solid waste attributes of the products. Just as energy costs made fuel efficiency a viable marketing strategy, producers could apply disposal impacts to product design and marketing.

Another issue for producers is the lack of information and exchange of information on source reduction. For production processes, progress to reduce volumes of waste in-plant is common and is driven by the need to minimize costs and stay competitive. There is little evidence of major efforts to design consumer products to reduce waste volume and toxicity, however, so little expertise and few references are available. The flow of information about source reduction would improve if consumers and industry recognized waste impact as an important product attribute.

b. Solid Waste Management Options Available

Local officials often lack information on the alternatives to traditional means of solid waste management. The first information issue that local officials must face is what alternatives are viable given the local situation. Each community has a distinct combination of factors that affect the choices they have. The factors include waste composition, landfill capacity, proximity to scrap markets, energy markets, and demographics. Obtaining information about these alternatives may be time consuming and expensive and thereby prohibit a full assessment of options.

A second issue facing communities is the set of legal and regulatory requirements that affect their solid waste management program. Uncertainty about these requirements may make communities shy away from particular options in order to avoid uncertainty in the future.

A final information need for local officials is how other communities have responded to their own solid waste problems. Although each situation is unique, communities could benefit from information about other local responses, including financing approaches.

In each of these cases, information will improve the decision that communities make with regard to solid waste management: with limited information (or even misinformation) on any of these topics, communities may not choose the most effective solution for their solid waste problem.

c. Comparing and Evaluating Options

Communities must examine a range of issues when assessing solid waste management options. Lack of information about the consequences of the options will hinder their decision making and may lead to a misallocation of resources. Another important problem is the quality of information on which communities rely.

For example, we have referred frequently in this report to estimating true costs. As described in chapter 2, the failure to consider the true costs of waste management options may lead to an inefficient allocation of resources. Even if local officials do pursue this course and collect the data, the costs will still reflect uncertainty in future market conditions, regulatory changes, and liability.

Similarly, comparing the effects of alternatives on human health and the environment is complex and uncertain. The information required for a health risk assessment, for example, is technical and often represents professional judgment rather than empirical fact. Although local officials must consider the health and environmental effects of alternatives, the information required may severely limit the scope of the comparison.

The public is equally at the mercy of the uncertain and potentially biased information about alternatives. They are often unable to even understand the difference between a solid waste management facility and a hazardous waste management facility. Their perceptions of the hazards caused by these units are swayed by the force of the messages put forth by proponents and opponents of the projects. They have no unbiased source to communicate clearly the actual consequences of a well-operated facility that is designed in compliance with the relevant statutes. From this uncertainty comes distrust and siting opposition, as mentioned earlier in this chapter.

Assessing the cost, human health, and environmental impacts of alternative waste management strategies is very expensive. In chapter 2, for example, we estimated the cost to a community for a 500 TPD incinerator at a minimum of $2 million for the siting process alone. At some point the cost of additional information will exceed its value. For example, an educated guess about the likely range of future scrap material prices may be sufficient to justify a recycling program. If the program is viable, and prices are anywhere in the acceptable range, the community would be ill-served to spend additional money for an indepth analysis of scrap markets and point projections of scrap revenues for the next 20 years. Although a lack of information may pose a barrier to more effective solid waste management, complete information is not necessary to improve its effectiveness.

Finally, local officials need information on how alternative programs will work in their communities. Thus, there is a need to know not only how other communities have responded to solid waste issues, but also how effective the alternatives have been.

CHAPTER 3

OBSTACLES TO MORE EFFECTIVE SOLID WASTE MANAGEMENT

H. SOCIAL INFRASTRUCTURE

The traditional solid waste management options of landfilling and incineration require only minimal participation on the part of individuals, businesses, and institutions. Simply stated, a person places solid waste at the curb and it "disappears" with no further action on the part of the individual. Individual responsibility is minimal, and the assessed costs of disposal are not directly related to products and materials discarded. Thus, there is no particular economic incentive for individuals to be aware of or concerned about the cost or impact of solid waste management.

When solid waste management options shift to source reduction measures and to recycling, a fundamental change takes place in the infrastructure required to pursue these options: citizens and employees of corporate and government entities outside of the existing solid waste management system must assume responsibility individually for their wastes and must directly participate in their handling. On a national scale, this means that millions of people will be involved in very direct and personal ways. The practice of more effective solid waste management is especially challenging because of this need to involve citizens directly. The more complex solid waste management alternatives require new infrastructure and new management skills to involve individuals more actively in solid waste management practices like recovery for recycling.

Probably the most effective motivator for a conservation ethic among individuals is some form of economic incentive. At present individual citizens have limited concepts of the costs of solid waste management. Fees, for example, are often collected as a part of general taxes, or are collected annually. Few communities practice rate design to encourage less waste to be disposed or to encourage recovery for recycling.

The following situations within the social infrastructure present obstacles to enhancing the solid waste management practices of recycling and source reduction.

1. High-speed copiers, telecopiers, computers, and the like have accelerated the exchange of information and the capacity to produce information. This has also lead, however, to an expansion of "hard copy". The hard copy typically has a short useful life and is discarded as waste.

2. Demographic changes are leading to the demand for more individualized products and packaging. The principal changes are: smaller households, more singles, and smaller families.

3. The work force is continuing to expand, with more working mothers and fathers in both one-income and two-income families. This means that prepared foods, "fast food", disposable packaging, and disposable products are more likely to be sought by persons with time constraints.

4. single-use products and packaging have become more prevalent. The basis of this has often been to ensure cleanliness of the product, and the unit costs are often very low. Individualized packaging can also result in less product waste.

5. The high cost of labor for product repair tends to perpetuate the discard and replacement, rather than repair, of products.

6. The distribution of products is based on a finely-tuned system of single-use products and packages to serve the purchasing habits of the vast majority of people. The infrastructure to reverse the flow of the products and materials after their useful life is not as refined.

7. Only a small segment of society now participates in recycling and waste reduction measures. Expansion must reverse a well-entrenched trend toward "easy" disposal. It will be necessary to educate and train millions of people to participate in municipal solid waste management options at home, in retail stores, and in the workplace.

8. Few schools, businesses, or governments promote more "enlightened" solid waste management options. Consequently, public consciousness of these options is low. At present there are no incentives in place to promote such a role for these institutions.

9. Competition in retail stores, especially food stores, leads to massive marketing efforts by producers. Products that were once marketed to consumers (who then create demand) are now marketed instead directly to retailers in order to capture shelf space and to promote a high turnover rate. As a result, producers utilize intense promotion, more advertising, more eye-catching packaging and product design, and larger packages. Efforts to combat pilferage and product tampering also contribute to increased packaging that ends up as waste.

10. In many cases, recycled products or packaging carry a stigma of being less desirable or less capable of performing the same service as a comparable product or packaging made of a virgin material. In some cases the recycled product may cost more in order to meet the performance criteria.

Although change is now a fact of life in both individual circumstances and in competitive business enterprise, most persons as individual citizens and as workers are most comfortable with the "status quo." Thus, new criteria in product design or attempts to change individuals' habits often meet with inertia or resistance. This is possibly more so because other changes to which people are subjected in social and business circumstances are beyond their control. During the stresses of World War II these kinds of changes took place very effectively. Changing individual and corporate practices in a situation where the population is much larger and more diverse and where most people are relatively prosperous and uninhibited by forced restraints is a significant challenge.

Modifying the solid waste management system to achieve source reduction and to increase recycling will require a very significant education effort and restructuring of the habits of individual citizens in their homes and employment settings. The societal infrastructure will require substantial change.

CHAPTER 3

OBSTACLES TO MORE EFFECTIVE SOLID WASTE MANAGEMENT PRACTICES

I. ORPHAN WASTES

1. INTRODUCTION

Historically, certain wastes such as tires and car batteries have not been an integral part of the waste stream. In general, these wastes are not collected with other municipal waste, and are not welcome in landfills or incinerators (although some incinerator operators accept small amounts of tires). Although many batteries are recycled, as many as 31 million batteries per year could be stored or simply abandoned. Tires are also a problem; perhaps as many as 3 billion tires are in tire piles scattered throughout the country. And, about 200 million tires are replaced each year.

2. CAR BATTERIES; OBSTACLES TO GREATER RECYCLING

Car batteries should not be disposed of in either landfills or incinerators because of the concern over lead in leachate and emissions. Unfortunately, there are serious obstacles to the recycling of car batteries.

In the early 1960's as high as 97% of car batteries were recycled to recover the lead. Since then, several factors have caused a decline to below 70%:

- The lead market has dropped substantially.
- Costs of compliance with environmental regulations has increased because lead is a hazardous substance.

- Concerns by recyclers about liability for any health or environmental damage.

3. TIRES; OBSTACLES TO INTEGRATED WASTE MANAGEMENT

Tires are difficult to handle in landfills because they tend to rise to the surface, rather than remain buried. They also make it difficult to control the temperature in incinerators. Markets for recycled tires are very limited, as they are for other products from shreedded tires. As a result, tires tend to be abandoned, either legally or illegally in lots or even along the side of roads. Apart from being an eyesore, tires can serve as a home for disease-spreading insects. In addition, tire piles can catch fire and burn for extended periods of time--one fire burned for eight months. The main obstacles to integrating tires into the waste management stream are:

- Tires have very limited utility once they have worn out; they need to be shredded to be effectively landfilled, incinerated or recycled. However, it is costly to shred them.

- Markets for both tire-derived fuel for incinerators and other uses of shredded tires (e.g., use as a material in roadbeds) are poorly developed.

- It appears to be cheaper and easier to simply abandon tires than to pay for proper waste management.

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CHAPTER 4

OPTIONS TO IMPROVE MUNICIPAL SOLID WASTE MANAGEMENT

A. OPTIONS TO ENHANCE INTEGRATED WASTE MANAGEMENT (IWM)

The options to enhance integrated waste management are grouped according to their contributions to planning, participation, and prevention. The specific options discussed are:

Planning

- Goal setting at the State level in terms of percentages of MSW landfilled, recycled and combusted.
- Characterizing MSW stream prior to selecting options.
- Enterprise accounting to compare true cost of alternatives.
- Requirement for record keeping on the weight of MSW collected and disposed.
- State planning for MSW management as eligibility requirement for EPA assistance.
- Federal program grants requiring a State match.
- Federal actions to improve siting.

Participation

- Research, Development, and Demonstration
- EPA development of publications on all aspects of MSW management, including facility siting.
- Joint industry-government council on MSW.
- EPA running or funding a clearinghouse for publications.
- Clearinghouse of publications run by an

association of governments or public interest groups.

- Direct technical assistance by EPA to State and local governments.
- Peer matches for university professors or other experts to provide technical assistance.
- EPA technical assistance through contractors.
- EPA funding of waste management advocate in several government organizations.
- EPA sponsorship of PBS or commercial television specials/documentaries on the issues/problems.
- Development of training materials, especially videotapes for grade school children.
- User charges to disclose true disposal costs to homeowners.

Prevention

- Requirement for manufacturers to label all household products containing hazardous materials.
- Requirement of percentage goals for recycling and recovery prior to issuing landfill or incinerator permits.
- Model siting program documentation.
- Requirement for percentage of Federal purchases to contain recycled products.
- Stronger enforcement of existing land disposal, incinerator emission, and ash disposal regulations.
- University programs on MSW topics.
- State certification programs for solid waste facility operators.

The basic concept of integrated waste management is that each community consider a mix of waste management options, rather than a single solution, when assessing its needs and alternatives. In this way, the community custom tailors its system to its unique individual needs. This may mean a strong, though not complete, reliance on landfilling in remote areas where land is available but recyclable materials are not available in marketable quantities; and a strong reliance on recycling in more densely populated areas close to markets.

In integrated waste management, communities consider source reduction and recycling to the extent feasible. Although source reduction is the least developed option, it is nonetheless the only way to reduce the total quantity of material flowing into the waste stream. As discussed elsewhere, recycling can serve well to conserve materials and energy and reduce the burden on landfills and incinerators. Landfilling and incineration continue as viable alternatives for communities to assess in dealing with wastes remaining after source reduction and recycling measures.

In applying the integrated waste management approach, communities must understand their waste stream, their needs, and the strengths and weaknesses of the waste management alternatives. They must also carefully consider local and regionalized opportunities as they plan and set goals.

In recent years, the major MSW problem has been that of facility siting, whether the facility be a landfill, incinerator, or recycling center. The "not in my backyard" or NIMBY syndrome can delay decision making to the point of crisis. Therefore, any integrated waste management system must provide for aggressive actions to address the siting impasse that may occur.

The terms "communities" and "local governments", as used in this context, refer to those sectors of the government that are responsible for providing waste collection and disposal service for its citizens. This responsibility derives from the traditional governmental police powers and public health authorities long associated with solid waste management and other local government functions. It is important to recognize that these responsibilities can be carried out as a government service, as a private service, or as a combination government/ private service. Over the years, a substantial private solid waste management service industry has developed in this country. Private firms have demonstrated the ability to serve a meaningful and productive role in managing solid wastes in concert with local government.

The options to enhance integrated waste management cut across the various solid waste management alternatives, so they complement those options discussed in other parts of this chapter. They comprise actions that foster improved waste management through better information for decision making, better public education and awareness, and stronger incentives to reduce the problems associated with poor MSW practices.

1. PLANNING

a. Set quantitative goals at the State level to establish target percentages for source reduction, recycling, incineration, and landfilling.

Pros:

- Allows State to work with local government to establish targets for recycling, landfilling, incineration, etc.
- Sets stage for local planning and implementation.

- Sets a yardstick for measurement of progress.
- Provides framework within which local government can custom tailor its objectives.

Cons:

- Sets stage for criticism if goals are not achieved.

b. As part of planning, characterize the waste stream at the local level prior to selecting management options.

Pros:

- Provides a basis on which the community can custom tailor a combination of options best suited to its needs.
- Provides valuable information for quantification of cost tradeoffs.
- Points the way toward options reflecting local conditions (e.g., Florida communities with a long growing season and high percentage of yard wastes may use alternative yard waste options to significantly reduce the landfilling burden).

Cons:

- Can serve as an excuse for delay in selecting options.
- May be improperly viewed as a costly research project, rather than a valuable planning effort.

c. Local governments can use true-cost accounting to accurately assess and report the total costs of all facets of the solid waste management system. This means developing a cost center that accurately reflects all costs of the service provided to system users.

Pros:

- Provides a basis for comparing costs of current system with that of other options.
- Provides information to make the public aware of all system costs, including costs that are frequently "hidden" (e.g., permit costs, and costs of postclosure care).
- Provides a basis for establishing user fees.

Cons:

- Community may have to seek outside assistance in setting up accounting system and identifying all relevant costs.

d. States require accurate record keeping and reporting on weight of solid waste collected and disposed.

Pros:

- Provides State with information necessary for capacity needs assessment and planning for additional capacity.
- Facilitates identification of trends for planning.
- Facilitates accurate correlation of tipping fees and user fees with system costs.

Cons:

- Cost of installing and operating scales at facilities.

e. Make State planning for Statewide MSW management an eligibility requirement for EPA financial assistance programs under all environmental statutes (Clean Air Act, Clean Water Act, Superfund, etc.). Planning would include a State "waste balance" that would quantify short- and long- term solid waste generation and match it with existing and anticipated recycling, incineration, and landfill capacity.

Pros:

- Provides the necessary tool for States to work rationally and knowledgeably with local government to deal with their current MSW problems and prevent future problems.
- Provides for cross-media assessment of solid waste; i.e., impact on surface and ground waters, air (combustion and transport vehicle emissions), and long-term liability.
- Provides structure for regional solutions both within and outside the State to enhance alternatives available to communities.
- Funding eligibility provides an incentive for States to plan in a context of multimedia concerns.
- Allows tailoring of solutions to meet differing regional needs.

Cons:

- States may resist linking funding eligibility to planning requirement.
- Planning may be viewed as an excuse for inaction.

f. Provide Federal grants to States, requiring a State match, to establish permanent MSW programs.

Pros:

- Planning could be an eligibility requirement, would foster examination of cross-media impacts of problems and solutions.
- Using of short-term grants would foster State efforts to become self-sufficient.
- State match requirement ensures State interest and leverages Federal resources.
- Maintains a pool of expertise at State level for technical assistance to local government, information development and dissemination, siting dispute resolution, and promulgation and enforcement of regulations to ensure adequate and safe capacity.

Cons:

- Fund may not be available.
- States may prefer to be independent of EPA.
- Long-term funding would reduce the pressure on States to solve their own problems.

g. Federal actions to improve siting: require States to establish and implement a mandatory dispute resolution process to apply where standoffs are unresolved after a specified time period; provide for State condemnation of land; provide for use of Federal lands as "sites of last resort", especially for Federal wastes.

Pros:

- Allows opportunity for interested parties to arrive at a solution prior to mandatory action.

- Ensures resolution of impasse in a timely manner, and does not allow "no site" as a possible outcome.
- Availability of Federal lands demonstrates commitment of Federal government.

Cons:

- May be viewed as inappropriate Federal intrusion into local affairs.
- Potential liability problems may accompany Federal land use.
- Federal authority in this area may be questionable.

2. PARTICIPATION

a. Establish Federal research, development, and demonstration (RDD) matching funds program.

Pros:

- Provides national leadership role in technology development to improve efficiency of recovery techniques, improve separation or combustion processes, and improve safety of landfilling.
- Municipal waste Innovative Technology Evaluations (MITE): By funding evaluations, rather than construction, fosters investment by private and other government funding sources.
- Leverages Federal funds.
- Avoids duplication by States and others.

Cons:

- Funds may no be available.
- Communities may delay action, anticipating an

imminent solution.

b. EPA should develop publications and data from case studies and demonstration projects on MSW management practices.

Pros:

- Efforts would be concentrated under a single institution that assesses issues and options, and publicizes better approaches and lessons learned.
- EPA is generally considered a reliable, independent, and unbiased source of such information.

Cons:

- Funds may not be available.
- Unsuccessful demonstrations might be funded.

c. Establish a joint industry-government council on municipal solid waste.

Pros:

- Provides framework for joint research agenda and shared sponsorship of research projects.
- Provides forum for policy debate.
- Ensures continued national leadership in both industry and government.
- Establishes single national focal point to comprehensively address products that ultimately become solid waste, as well as and management of the waste stream itself.
- Fosters interaction among all levels of government and manufacturing industry on a focused area of mutual interest.

Cons:

- Difficult to select representatives from broad spectrum of industry and government.
- Staff assistance required to maintain continuity.

d. Establish a clearinghouse under EPA sponsorship for MSW information and publications.

Pros:

- Provides a readily accessible, centralized, and current information source.

Cons:

- Funds may not be available.

e. Set up information clearinghouses operated by associations of local governments and public interest groups.

Pros:

- Uses established distribution channels to association memberships.
- Fosters a sense of competition among associations to better service their client memberships with current information.

Cons:

- Associations may not have funds for such a venture.
- MSW may be a low-priority issue for the association.

f. Have EPA staff provide direct technical assistance to State and local government and others on MSW issues and problems.

Pros:

- o Expertise is directly available to decision makers who normally do not have access to technical staff.
- o Staff learns by sharing skills with others.
- o Assistance is viewed as unbiased and reliable.
- o Overcomes institutional barriers and shares success stories (done successfully by EPA in over 200 communities in the 1970's).

Cons:

- o Resources (Full-Time Equivalent) may not be available.

g. Provide technical assistance from one local or State official to another through a peer-to-peer or "peer matching" program.

Pros:

- o Provides a meaningful coordination opportunity for associations of State and local officials.
- o Assistance is viewed as especially credible because it is provided by persons who have personally dealt at the same level with the same set of problems.
- o Independent nature of the expertise adds to the credibility.

Cons:

- o Peer experts may be unavailable because of other commitments in their usual line of duty.

- May require funding assistance.
- Funds may not be available.

h. Provide EPA technical assistance through contractors hired by each Regional Office to aid State and local governments and others.

Pros:

- Provides opportunity for aggressive and flexible program.
- Can be tailored to each Region's needs.
- Is less demanding on EPA Full-Time Equivalent allocations.
- Makes expertise available to parties who couldn't otherwise access it.

Cons:

- Contractors may have certain biases.
- Funds may not be available.
- Oversight by EPA employees is required.

i. Have EPA sponsor solid waste Advocates/Program Directors in associations of local governments.

Pros:

- Provides readily accessible communication/focal point in a communication system already in use by the membership.

Cons:

- Groups may prefer to maintain independence in order to lobby and take strongly opposing views to those of EPA.

- Fund may not be available.

j. Have EPA sponsor PBS or commercial network television documentaries on municipal solid waste issues.

Pros:

- Provides widespread exposure of individuals to the issues, problems, and solutions.
- Is a meaningful consciousness-raising opportunity.
- Provides an opportunity for industry-government cooperation in developing and sponsoring documentaries.

Cons:

- Funds may not be available.
- Industry (including television) must be willing to participate.

k. Have EPA sponsor development of training materials to educate individuals on various aspects of solid waste management, including consumer responsibilities. Focus on training materials for school children (videotapes, curriculum modules, etc.).

Pros:

- Fosters acceptance of responsibility.
- Provides for public support of improved local decision making.
- Helps children form desirable attitudes and habits that they can take home.

Cons:

- Funds may not be available.
- Educators may be reluctant to incorporate

additional material into programs.
- A dissemination program will be required.

1. Encourage local communities to assess "user charges" for solid waste management services. As with other public and private services, user charges are fees charged to system users that are directly tied to the cost of the service received. User charges may be based on the cost of providing service to the household or business or may be based on the cost of handling each unit (bag, can, or pound) of waste. In either case, the charge assessed the user must reflect the total costs of the system.

Pros:

- Makes public aware of the costs of the service they receive as a result of the waste they produce.
- Encourages citizens to reduce waste generation to reduce charges.

Cons:

- May require substantial changes in the community tax system.
- Citizens may lose as a tax deduction the portion of their local tax that becomes the user fee.
- May increase litter as system users dump in vacant lots or in someone else's dumpster to avoid paying more for disposal.

3. PREVENTION

a. Require manufacturers to label all household consumer products (which ultimately become waste) that contain hazardous constituents and indicate appropriate disposal option.

Pros:

- Provides incentive for manufacturers to remove hazardous constituents from their products.
- Provides incentive for consumers to buy safest products.
- Helps direct waste to appropriate disposal process.

Cons:

- Costs industry to test and label products.
- Costs to develop, impose, and enforce requirement.

b. Require percentage goals for recycling prior to issuing a landfill or incinerator permit. That is, use the facility permitting program to ensure that facilities are part of integrated waste management.

Pros:

- Encourages facility planners to consider recycling.
- Fosters State planning to aid goal-setting.
- Enhances citizen support for facility as part of an integrated waste management system.
- Fosters public debate and interest.

Cons:

- Encumbers the planning/permitting process

c. Have EPA document and distribute model siting process used successfully by communities.

Pros:

- Provides an example for communities to follow.

Cons:

- Regional and local differences may limit applicability.

d. Require a portion of all Federal (Federal agencies and Federal contractors and grantees) purchases of paper, steel, aluminum, and plastic to include some recycled or recyclable material within a specified time frame.

Pros:

- Sets an example for other sectors of society.
- Fosters the establishment of materials standards.
- Enhances the market for recycled materials.

Cons:

- Materials may be more costly.
- Some agencies with unique material requirements may resist this requirement.

e. Enhance Federal and State enforcement of landfill and incinerator regulations.

Pros:

- Eliminates the cheap option of unacceptable practices.
- Reduces emissions.
- Demonstrates government concern.

- Fosters acceptable practices, including source reduction and recycling.
- Fosters better planning.

Cons:

- Federal authority in this area is limited.
- Can be costly.

f. Establishing accredited university programs or minor fields of study in MSW topics (e.g., waste combustion engineering, MSW economics, solid waste planning, etc.).

Pros:

- Legitimizes appropriate fields of study, fostering availability of educational programs.
- Provides permanent supply of qualified practitioners.
- Advances the state of the art of MSW management.
- Improves planning, design, and operation.

Cons:

- Universities may view field as too narrow.
- Can be costly.

g. Establish state certification programs for operators of solid waste combustors and sanitary landfills and for recycling coordinators.

Pros:

- Improves quality of facility operations.
- Improves public acceptance of facilities.
- Provides opportunity for State-Federal-industry

cooperation.

- Decreases facility liability.

Cons:

- Funds may not be available.
- States may be unwilling to implement.

CHAPTER 4

OPTIONS TO IMPROVE MUNICIPAL SOLID WASTE MANAGEMENT

B. OPTIONS TO INCREASE SOURCE REDUCTION

Source reduction is widely promoted in principle but rarely applied in practice. The American economic system has evolved with little or no regard to waste generation. Consumer demands for convenient, low-cost products are met by manufacturers' product designs. There are no incentives for manufacturers to design, nor for consumers to buy, products that will result in waste of lower toxicity and quantity at the end of their useful lives. To the contrary, incentives that foster a "throwaway society" abound.

Options to counter this trend and foster source reduction objectives include government-imposed regulation, incentives and disincentives, and education and promotion leading to voluntary actions. Source reduction objectives may not reasonably apply to all components of the waste stream and, when candidate materials or products can be identified, the appropriate source reduction measures must be chosen.

The following discussion will:

- Propose a decision framework for identifying source reduction candidates;
- Propose a decision framework for choosing among source reduction options; and
- Outline the pros and cons of the individual source reduction options

The intent of this section is to provide the reader with a basic understanding of the complex issues and choices involved in moving source reduction from theory into practice. The review of options will highlight the options and associated pros and cons, rather than present detailed analyses. (Readers can refer to the sources cited at the end of this section for references to more comprehensive studies from which the general concepts provided here were largely derived).

1. IDENTIFYING SOURCE REDUCTION CANDIDATES

Which components of the waste stream should be
candidates for source reduction?

Source reduction measures could affect broad segments of society: product designers, manufacturers, advertisers, distributors, wholesalers, retailers, consumers, and waste handlers. Applied in the marketplace, source reduction measures could, through education, regulation, incentives or disincentives, alter consumption patterns or the availability of products, inducing shifts in lifestyles to which Americans have become accustomed.

The management of solid waste is not the only or even the most important consideration for manufacturers or consumers. It should, however, be one of the factors given consideration when design and comsumption decisions are made. The approach needed would mitigate solid waste management problems, yet not impact lifestyles so severely that it is rejected by those who must implement it and those who are supposed to benefit from it.

The method of developing a decision framework for identifying potential source reduction candidate materials or products is to draft a list of criteria derived from the objectives of source reduction. The criteria could then be used to rank candidates. The proposed criteria are:

- Toxicity: Which materials/products/packaging contribute the most to toxicity that affects humans and the environment?

- Contribution to quantity: Which materials/products/packaging constitute the largest percentage of the waste stream?
- Useful life: Which materials/products/packaging have short useful lives (i.e., become part of the waste stream quickly)?
- Contribution to litter: Which materials/products/packaging are found most frequently in the "litter stream"? (Many litter stream items have short life spans and, had they been disposed of properly, would have become part of the municipal solid waste stream.)

The potential candidates for source reduction suggested by these four inital criteria include:

a. Toxicity Contributors

The major toxicity contributors are lead, cadmium, mercury, and chromium.[1] The potential sources of these toxics include batteries, inks, plastic (pigments and fixatives), paper, rubber, and leather products.

Many other chemicals and products known to contribute to the toxicity of solid wastes are categorized as hazardous household wastes. Some examples of these are used oil, antifreeze, auto batteries, paints and paint solvents, mercury batteries, insecticides, and herbicides. These items are often discarded with solid wastes when they should be kept separate. Programs addressing household hazardous wastes focus on educating the consumer to shift consumption to less toxic alternatives and to separate toxic products from ordinary household waste. These can then be placed out for special collections or taken to special sites where they can be disposed of properly.

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[1] Goldberg, Daniel. "Incinerator Ash: New Problems for Landfills," Recycling Today, May 1988, p. 67.

Although source reduction does address the problem of household hazardous waste by aiming to minimze toxicity, household hazardous wastes are being handled through programs specificlly geared to them.

b. Significant Quantity Contributors

The table below indicates the percentage distribution of total discards for materials and products that are major contributors to the solid waste stream.

Item	Percent of Discards	
Paper and Paperboard		
Corrugated Boxes	8.1	
Newspapers	6.3	
Other Nonpackaging Paper	3.8	
Office Papers	3.6	
Other Paperboard	3.6	
Books and Magazines	3.1	
Paper Packaging	2.8	
Commercial Printing	2.3	
Tissue Paper and Towels	2.1	
Total		35.7
Yard Wastes		20.1
Food Wastes		8.9
TOTAL		64.7

Source: Franklin Associates, Ltd. Characterization of Solid Waste in the United States, 1960 to 2000 (Update 1988), final Report, March 30, 1988; Table 2, p.7 and Table 4, p.12; 1986 data.

c. Items with Short Useful Life Spans

A similar distribution can be made for items that have short life spans and enter the waste stream quickly.

Item	Percent of Discards	
Containers and Packaging		
Paper and Paperboard	14.5	
Glass	7.6	
Plastics	4.0	
Steel	1.9	
Wood	1.5	
Aluminum	0.7	
Miscellaneous packaging	0.1	
TOTAL		30.3
Nondurable Goods		
Newspapers	6.3	
Books and Magazines	3.1	
Office Papers	3.6	
Commercial Printing	2.3	
Tissue Paper and Towels	2.1	
Other Nonpackaging Paper	3.8	
Clothing and Footwear	2.1	
Other	2.0	
TOTAL		25.2

Source: Franklin Associates, Ltd. Characterization of Solid Waste in the United States, 1960 to 2000 (Update 1988), Final Report, March 30, 1988; Table 2, p.7 and Table 4, p. 12; 1986 data.

d. Items that Contribute Significantly to the Litter Stream

Unlike products that enter the solid waste stream through disposal, some products are discarded as litter. The major components of highway litter are shown below.

Items	Percent
Paper	60
Metals	25
Plastic	10
Other	10
Glass	5

Source: Department of Transportation data from approximately 1985.

The four criteria derived from source reduction objectives pinpoint materials, products, containers and packaging that contribute the most to the toxicity and quantity problems that source reduction measures aim to minimize. Source reduction objectives, however, are not the only factors to be considered in identifying potential source reduction candidates; other possible critria are:

- o Substitutes/Alternatives: Are comparable substitute materials or products available at about the same cost and function, yet more consistent with source reduction objectives?
- o Social good or need served by item: Is there a special or important benefit to society that the product or package serves? (ex: tamper-resistant packaging)

Note that these last two criteria would require more subjective responses than the first set of criteria that were based on the objectives of source reduction.

Once an approach has been proposed for identifying candidates (materials, products, containers and/or packaging) for source reduction measures, a framework is needed to identify whether any source reduction options should be directed toward chosen candidates and, if so, which one(s) would be appropriate.

2. CHOOSING AMONG SOURCE REDUCTION OPTIONS

Which measure(s) would best address the problem posed by the chosen candidate material product, or package?

Many issues must be considered in order to choose appropriate source reduction measures to direct toward candidates that have been identified. Before reviewing the source reduction options themselves, some consideration should be given to the following factors:[3]

- Effectiveness in achieving source reduction goals.

  The impact the measure being considered is likely to have in stimulating source reduction objectives (i.e. reduced toxicity and/or quantity.

- Ability of the free market system to address the problem.

  Free market principles state that policies should not interfere with the free choices of producers, consumers, and local governments to make decisions. The basic belief in this regard is that the private market system should be the primary mechanism for allocating society's resources. Adherence to this principle, however, does not mean blind faith in the status quo. Shortcomings in market structure or the absence of effective private mechanisms required government involvement to assure the efficient and equitable functioning for the competitive private enterprise system.

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[3] The source for all but 2 of these factors is Research Conservation Committee, Choices for Conservation, Washington, D.C., 1979, pp. 39-41.

- Consistency with the "polluter-pays" principle.

  According to this principle, the responsible segments of society (whether they be industries, individuals or both) should pay for preventing, controlling, and correcting the damage and waste that they create.

- Social and economic equity.

  Any significant policy, if effective, creates changes. In developing, evaluating and recommending policies for source reduction, the interests of the various groups likely to be affected must be considered in order to avoid disproportionate or unintended burdens.

- Economic efficiency.

  Economic efficiency requires comparing total social benefits with total costs to ensure that society does not sacrifice more goods and services than are justified by the benefits of the policy being considered.

- Administrative feasibility and cost.

  A potential policy measure should not require information or data that cannot be acquired at reasonable cost. From a practical viewpoint, the total cost of administration and enforcement of any given policy for both public administrative agencies and private parties should be small compared with the benefits derived.

The first factor listed above ("effectiveness in achieving source reduction goals") suggests that the objectives of reducing volume and/or toxicity might be best addressed by management options other than source reduction (or by a combination of approaches). For example, in aiming to reduce volume and toxicity with respect to newspaper, source reduction might be achieved by reformatting to use less space or by using inks with no toxic compounds. Recycling, however, has proved to have a significant impact on newspaper and will probably be best able to handle the majority of waste newspaper, while source reduction may help recycling by minimizing toxicity levels.

3. OPTIONS TO PROMOTE SOURCE REDUCTION

The options outlined below could all be used to stimulate source reduction activities. Although they have been divided into three categories (regulation, economic incentives/ disincentives, and education and recognition), options from each category could be used concurrently. For example, a consumer awareness campaign could be coordinated with a tax; the tax would not only raise money but could influence changes in consumption habits. As stated earlier, the review of options below is not meant to provide indepth analysis, but rather to convey the basic concepts and pros and cons associated with the options.

a. Regulation

Regulatory approaches include prohibitions and controls (restrictions, reporting, testing, approval and labeling requirement) on product and package design, manufacture, marketing, and purchasing. One avenue that EPA could explore, is whether the Toxic Substances Control Act (TSCA) could be used for the first three procedures oulined below. Coordination with FDA should also be considered when applicable.

(1) Product Constituent Regulation

This source reduction option would target constituents that are known to be in the waste stream and known to be toxic. Regulations could be directed to new and existing products or packaging. The aim of this option would be to identify toxic constituents and recommend changes if suitable alternatives are available. A range of regulatory options could be used, including product bans, cautionary labeling, approval labeling, and further study.

Pros:

- Reduces waste toxicity.
- Increases public awareness.
- Free market system function.

Cons:

- Standards for constituent identification are lacking.
- Enforcement is costly.
- The government intercedes in the market system through bans.
- Administering the regulations is costly.

(2) New Product Approval Process

Under current government programs, certain new products can enter the commercial market only after the manufacturers have complied with advance notification, testing, approval, and labeling requirements. These requirements are designed for consumer health and economic protection (e.g., food contact uses for new packaging materials, truth in advertising), and are not concerned with wastes associated with the product. However, the quantity and toxicity of waste resulting from a product at the end of its useful life could also be considered to impact consumer health and economy.

Manufacturers could be required to notify EPA before introducing a new product or package. The manufacturer would test new products or otherwise demonstrate the impact of the products on the waste stream. The manufacturer would conduct tests, or demonstrate why tests were unnecessary, to determine how the product would perform in a landfill environment, in an incinerator, and in a mixed-waste recycling/processing system. For products demonstrating an adverse impact, EPA would balance the impact against the benefits of the products. If the impacts were greater than the benefit, EPA could exercise regulatory options ranging from labeling to bans, and further study to assess the product's benefits and impacts.

Pros:

- Reduces toxicity of wastes.
- Integrates waste concerns into manufacturers' decision-making process.
- Improves functioning of waste management facilities.

Cons:

- Testing protocol is lacking.
- Standards are lacking.
- Administering such a program is costly.
- The government intercedes in the market system.
- Industry will incur costs.

(3) Existing Product Reviews

Requiring manufacturers to assess the impact of every existing product they produce would be infeasible. However, there may be some existing products whose impact of the waste stream warrants examination. Criteria could be established to identify products and materials of concern because of waste toxicity. Manufacturers could then be required to test these selected products. Based on the testing or other information, EPA could exercise regulatory options ranging from labeling to bans.

Pros:

- Reduces toxicity of wastes.
- Integrates waste concerns into manufacturers' decision-making process.
- Improves functioning of waste management facilities.

Cons:

- Selection criteria are lacking.
- Testing protocol is lacking.
- Administering the program is costly.
- The government intercedes in the market system.
- Industry incurs cost.

(4) Procurement Restriction

Federal, State, and local governments control the procurement of large quantities of durable and nondurable goods. Control over large quantity procurements makes these government institutions reasonable candidates for regulations fostering procurement of goods that result in waste of lower toxicity and quantity. These regulations could also be extended to firms doing business with government institutions (such as school systems, prisons, government offices, hospitals, etc.).

Possible areas for developing procurement requirements are:

- Purchase of duplex (i.e. double-sided) copiers.
- Purchase of inks with no heavy metals.

- Purchase of remanufactured, repairable, reusable, and more durable products.
- Purchase of only double-sided printing.

In some cases, products resulting in less toxic and/or lower quantity waste may cost more than counterpart products. Where this occurs, changes in government procurement practices may be especially difficult to implement if the institutions are required to comply with least-cost or lowest-bid policies. The legal authority for government procurement may direct that purchasing requirements can deal only with performance of the goods in service. This narrow authority would not allow the purchasing agency to consider the waste which results when the goods have served their use.

Successful changes in government procurement practices may motivate industry to follow suit. Also, changes in government procurement could create a demand which would stimulate manufacturing changes, thereby making desirable goods more readily available for other consumer segments.

Pros:

- Reduces quantity and toxicity of wastes.
- Provides example for other consumer segments.
- Creates a market for desirable products, increasing availability for other consumer segments.
- Free market system functions as before.

Cons:

- Desirable products may cost more.
- Least cost or lowest bid policies may hinder implementation.

- Authority to develop appropriate procurement specifications may not exist.
- Inertia of existing procurement process may hinder implementation.

b. Economic Incentives or Disincentives

Economic incentives or disincentives could be used to counteract consumer demand for products that cost less or have other perceived advantages over products that result in less waste or less toxic wastes at the end of their useful lives. Economic incentives can be combined with regulatory measures and educational activities in a comprehensive source reduction program.

(1) Quantity-based Collection Fees

Public and private waste collection services can make customer fees commensurate with the quantity of waste generated for collection or with the frequency of collection. Variations of quantity-based fees exist but are generally designed to increase the cost of solid waste collection service to those households or businesses that produce more solid waste. In effect, those who reduce the quantity of waste generated are rewarded. To date, these systems have been employed to a limited extent, and their effectiveness has not been fully assessed.

Pros:

- By fostering consumer demand, rewards manufacturers of products designed to result in less toxic and lower quantity waste.
- Fosters "pay as you throw" principle.
- Increases consumer awareness.
- Reduces quantity and toxicity of wastes.
- Free market system functions as before.

- Can be used as marketing device by waste management services.

Cons:

- Effectiveness is unproven.
- May lead to littering of shopping centers, schools, and roadsides.
- Does not reduce waste toxicity.

(2) Taxes, Surcharges, Tax Credits, Subsidies, and Seed Money

Options that fall in this category have long been use to foster special causes and projects. Acceptance of such measures is reflected in the continued existence of depletion allowances, freight rate subsidies, and excise taxes. These economic devices can be used to sensitize manufacturers and consumers to waste quantity and toxicity. They can alter production and consumption practices and can also serve to generate revenue to manage wastes generated.

Taxes on less desirable products do not preclude manufacturers from producing them nor consumers from buying them; free choice continues to function. However, they can raise issues of equity among economic clases, i.e., potential for greater impact on the poor. None of these measures need be permanent. Rather, they can be applied to instigate changes to the existing system and be lifted later.

The likely success of the measures in this category in fostering the objectives of source reduction cannot be projected. However, they can provide incentives for manufacturers and consumers to alter their habits and can serve as a catalyst for new research and new projects.

For every product sold, levy a waste charge, identified as such on the package, commensurate with the quantity of waste resulting at the end of the useful life of the product or package.

Pros:

- Increases consumer and manufacturer awareness.
- Fosters "pay as you throw" principle.
- Rewards manufacturers and consumers of low-waste products.
- Reduces quantity of wastes.
- Generates revenues for waste management operations and research.
- Free market system functions as before.

Cons:

- Complex to implement.
- It may be hard tc justify the targets and size of tax.
- Administering the changes is costly.
- Interstate commerce concerns (if levied by State) can make this measure difficult to implement.

Tax rebates to consumers and/or manufacturers of reusable, repairable, remanufacturable, more durable, or refillable containers.

Pros:

- Increases consumer and manufacturer awareness.
- Reduces quantity of wastes.

Cons:

- Administering rebates is complex.

- A revenue source is needed for rebates.

Tax credits or subsidies for manufacturers conducting source reduction activities such as product redesign, product line modification, research and development (e.g. development of self-balancing automobile wheels to prolong tire life).

Pros:

- Tax credits function through existing tax system.
- Provides corporate example for nation.
- Fosters reduced waste quantity and toxicity.

Cons:

- Requires administrative guidance and oversight.

Tax credits to retailers who reserve specified amounts of shelf space for products designed for less and lower toxicity waste.

Pros:

- Fosters consumer awareness.
- Enhances consumer opportunity to buy desirable products.
- Functions through existing tax system.
- Instills waste management as a decision-making factor for manufacturers and marketers.

Cons:

- Requires administrative guidance and oversight.

Tax credits or subsidies for businesses specializing in the repair/restoration of products.

Pros:

- Reduces quantity of wastes.
- Tax credits function through existing tax system.

Cons:

- Requires administrative guidance and oversight.

Tax credits or subsidies to businesses participating in efforts to standardize products to facilitate repairability and interchangability of parts.

Pros:

- Reduces quantity of wastes.
- Tax credits function through existing tax system.
- Reduces consumer costs for product repair.

Cons:

- Requires administrative guidance and oversight.
- Detracts from corporate competition.

Subsidies to remedy freight rate inequities for reusable, refillable containers (and any other inequities identified).

Pros:

- Not complex to implement/administer.
- Reduces quantity and toxicity of wastes.

Cons:

- Revenues are required for subsidies.

Loans or grants could be given to stimulate research or initiation of pilot projects related to source reduction objectives.

Pros:

- Fosters reduced quantities and toxicity of waste.
- Increases industry participation and competition.
- Free market system functions as before.

Cons:

- Requires administrative guidance and oversight.
- Requires revenues.

Economic incentives, in general, can be excellent tools to reinforce regulations or awareness activities. They would be most effective as one component of a comprehensive source reduction program employing a variety of approaches.

4. EDUCATION AND RECOGNITION - Leading to Voluntary Actions

One of the main challenges for promoting source reduction is to access the tremendous potential for voluntary actions on the part of individuals and corporations. To motivate these actions it is important to identify areas where source reduction objectives overlap economic interest.

If the concept of source reduction is unknown or unclear, then even those who would make decisions and act in support of source reduction objectives cannot knowingly do so. Through education, various groups learn about source reduction goals and supportive actions they can take. Through recognition, those who act to foster source reduction are rewarded. Options in this category can be used in concert with regulatory and economic incentives and disincentives.

a. Manufacturers, Designers, Marketing Representatives, and Retailers

The potential exists for corporate America to assume a menaingful and effective leadership role in fostering source reduction. Of its own volition, corporate America can exert substantial influence among corporate bodies, on government, and on consumers across the nation.

Designers and the institutions in which they are trained can learn to incorporate source reduction concerns in classes and on the job. Advertising agencies can learn to look at source reduction qualities as positive attributes that can be used to sell products and inform consumers about their benefits.

The options listed below aim to stimulate source reduction by targeting the design and manufacturing aspects of a product's life cycle.

Awards: Well-publicized awards can be given to manufacturers, designers, marketing and advertising agencies, and retailers making outstanding efforts to produce or promote nontoxic, reusable, durable goods that result in less waste or less toxic wastes. Recipients could use the awards to enhance their marketing strategies.

Product Logos (Positive Labeling): A highly-publicized source reduction logo could be developed for corporate use on products that help to reduce the toxicity or quantity of waste resulting at the end of the products' useful lives, or which otherwise replace less desirable products or materials.

National Source Reduction Corporate Council: A National Source Reduction Corporate Council could be formed to review and develop policies; maintain dialogue among governments, manufacturers, retailers, and advertisers; issue awards; and develop and promote logos and seals.

Voluntary Procurement Policies: Procurement policies that consider source reduction issues were described earlier as an action that could be required of government institutions. Corporations are also large-quantity procurers that could foster source reduction through voluntary changes in procurement practices.

Industry-wide Packaging Guidelines: Industry-wide packaging guidelines could be used to foster increased consideration of source reduction concerns in the design of products, containers and packaging, thereby reducing the quantity and toxicity of wastes.

Corporate Research and Development: Voluntary research, development, and marketing activities can increase production of goods that are more durable or increase the durability of other products, thereby fostering source reduction (e.g, development of a tire valve stem that displays a visible or audible signal if tire pressure declines enough to reduce the tire's service life). Thus, repairability and durability can become new market areas for industry through development of repair modules and products to increase the useful lives of other, higher valued products.

Joint Research: Government and Industry: Government-industry cooperation can lead to developing and implementing a joint research agenda. This would allow even small businesses that are unable to support their own research and development programs to participate in source reduction research and development activities.

Seminars or Forums for Designers and Design Professors: Source reduction concern are not generally factors considered in the design of a product, container or package. Seminars or forums could be used to exchange information on source reduction concerns and on current practices in the education and work of designers in order to identify ways to incorporate consideration of source reduction concerns.

Raising Corporate Awareness: All of the above options wil serve to raise awareness and stimulate source reduction. Each, however, has certain advantages and disadvantages:

Pros:

- The options, coupled with consumer awareness, target responsible entities: those who design, make, package, market, and sell products that result in waste at the end of their useful lives.
- They are feasible to implement.
- They complement consumer awareness activities.

Cons:

- Direct measurement of results may not be possible for all options.
- Over the short term, costs may exceed quantifiable benefits, making program susceptible to corporate budget cuts.
- With major benefits likely only over the long term, short-term discouragement is possible.

b. Consumers

As procurers, the general public and businesses are generally not well informed about solid waste management problems, source reduction objectives, or what they themselves contribute to the problem and could do to minimize their impact. The options listed below would target the procurement, consumption, and use stages of a products's life cycle.

Media/public outreach: Through speaking engagements, and articles in magazines, newspapers and organization newsletters, the concept of source reduction and the role of the consumer can be conveyed.

In-store shopper awareness campaigns: Consumers can be reached at the point of purchase by using informational labeling or posters highlighting the value of products, containers, or packaging with source reduction qualities.

School curricula: Through educational materials, class discussions and projects, young consumers can learn about source reduction and ways that they can act to minimize their impact on the solid waste problem. An added benefit to this option is that children often have a significant impact on the purchasing habits of those with whom they live.

Raising consumer awareness: Like the options that will stimulate corporate awareness, the above measures can serve to raise consumers' awareness of the solid waste problem by attacking it at the source. Consumer awareness-raising measures, however, have both pros and cons:

Pros:

- Waste toxicity and quantity can be reduced.
- Influencing consumers can in turn influence manufacturers.
- The options are feasible to implement.
- The free market system functions as before.

Cons:

- The impact of these measures may be hard to quantify.

CHAPTER 4

OPTIONS TO IMPROVE MUNICIPAL SOLID WASTE MANAGEMENT

C. OPTIONS TO INCREASE/ENHANCE RECYCLING

The options to increase or enhance recycling are grouped as follows in this section: siting; financing; institutional; markets; existing industrial infrastructure; taxes; societal infrastructure; and recovery. The following individual options are discussed:

Siting

- Changes to local zoning ordinances.
- Cleaning up the appearance of recycling facilities.

Financing

- Grants to develop recycling programs (from Federal or State governments.
- Low interest/revolving loan funds (offered by State/Federal governments).
- Landfill surcharges.

Institutional

- Cooperation by State and local governments with the secondary materials industry.
- Study of impact of Superfund on recycling activities.
- Regulating recycling facilities as industrial materials facilities, rather than solid waste facilities.
- Study of Federal and State transportation laws.
- Regional processing facilities.

Markets

- Procurement of recycled materials and specification development.
- Research and development for new products having recycled content.
- Market development study.
- Requiring manufacturers to purchase recycled feedstock.
- Price supports for secondary materials.
- Standardizing the types of plastics to be used in certain products and packaging.
- Regional marketing organizations.

Industrial Infrastructure

- Consideration of recyclability as a factor in design of products and packaging.

Environmental Risk

- Study on human health and environmental impacts of recycling facilities.
- Banning hazardous ingredients from otherwise recyclable goods.

Tax and Subsidy Advantages

- Consumption tax credits for the use of secondary materials.
- Investment tax credits to build plants that use recycled materials.
- Lower property taxes for recycling facilities.
- Study of national tax policies for inequities.

Information/Education

- Standardized methods for measuring recycling success.

- Study of uses for homogeneous commercial/industrial wastes.

Societal Infrastructure

- Labeling products and packaging as recyclable or having recycled content.
- Recovery-oriented building codes for commercial buildings or apartments.
- Establishment of a National Recycling Council.

Recovery

- Programs for commercial and industrial recycling.
- Mandatory recycling by governmental agencies.
- Mandatory recycling for citizens, business, and industry.
- Coding of plastic products.
- National "Bottle Bill".

1. SITING

Expanding recycling activities will require the siting and construction of many new and expanded facilities associated with recycling, such as drop-off centers, processing facilities, and manufacturing plants that utilize secondary materials. These will include both publicly and privately owned or operated facilities.

a. Local governments should reexamine their local zoning ordinances to determine whether these present obstacles to siting facilities that are essential for recycling to prosper. In conducting such a review, local governments should carefully consider the impacts of the current zoning, as well as any changes, on existing local facilities and programs (private, public and nonprofit) associated with recycling.

Pros:

- Changes in many local zoning ordinances are essential in order to expand recycling facilities and services.

Cons:

- There may be public opposition to zoning changes that are likely to bring new or expanded recycling facilities to a neighborhood.
- In the past, some zoning changes have been focused on only allowing new businesses and have not considered the expansion of existing enterprises.

b. Facilities associated with recycling should be encouraged or even required to use landscaping or other screening methods to mask the unsightliness that often accompanies these operations.

Pros:

- Cleanup of these operations can help improve their public acceptance.

Cons:

- Such measures may be costly to facility owners and may not be enough to overcome public concerns, such as noise, odors, dust, litter, and truck traffic.

2. FINANCING

Increasing the amount of recycling in the nation will require capital for financing new and expanded facilities and operations. Capital is required for land, buildings, and equipment. Financing these costs can be difficult because of the financial risks involved with fluctuating secondary materials markets.

a. The Federal government or States could provide grants, possibly designed to match contributions made by the grantee, in order to establish or expand recycling operations.

Pros:

- o Grants have been used effectively in the past.
- o State grants can be linked to State oversight of the local municipal solid waste plan.
- o The basis for allotting grants is not financial risk, but is based on sound solid waste management practices and avoided cost of disposal.

Cons:

- o The availability of Federal or State money for grants is dependent on appropriations, and thus may not be readily and consistently available.
- o Grants can result in the grantee using the money inefficiently or failing to become self-sufficient independent of the grant.
- o Local municipalities may not want State oversight. Likewise, States may not want Federal oversight.
- o Unless carefully administered, grants could result in duplication and replacement of services already efficiently provided by private sector.

b. Lending institutions or Federal or State governments can give revolving or low-interest loans to municipalities or private businesses for funds to establish or expand recycling operations.

Pros:

- o These loans are attractive because they can offer financing at a lower interest rate for recycling projects, reducing the debt burden.

Cons:

- o Funding of services that duplicate existing efficent public or private programs should be avoided.

c. States and/or municipalities can mandate surcharges on landfills to provide revenues to finance recycling projects. The surcharge will serve to generate income, beyond the cost of the landfill operations, that can be directly applied to local recycling operations.

Pros:

- o Surcharges would be a viable source of funding for establishing or expanding recycling operations.
- o As the price of landfilling increases, the incentive to use them decreases. This in turn leads to greater motivation to implement recycling programs.

Cons:

- o Assessing and collecting the fees from the different parties associated with landfilling may be complicated.
- o Recycling programs generate non-recyclable wastes too and would be impacted by such a surcharge.

3. INSTITUTIONAL

a. State and local governments and the secondary materials industry should work together in planning new or expanded recycling programs. In some instances, State and local government planning has not included consideration of the existing collection, processing, and marketing industry. On the other hand, in some cases the existing industry has not shown substantial interest in helping to solve local waste management problems, i.e., being more a part of a community solution.

Pros:

- All parties can benefit if the efficiency of recycling programs is maximized.
  - Duplication of effort can be minimized.
  - Displacement of materials already being recycled can be eliminated.
  - Joint public/private programs are possible.

Cons:

- None

b. The Comprehensive Environmental Response, Compensation, and Liabilities Act (Superfund) should be studied to determine if the Act presents substantial obstacles to the increased recycling of waste materials because of its liability provisions.

Pros:

- The secondary materials industry claims that the Superfund law presents substantial obstacles to increased recycling. If so, we must understand those obstacles so that we can better define potential recycling options as well as the role that Superfund can and should play.
- Such a study will not require substantial resources.

Cons:

- None

c. Where recycling facilities are regulated as solid waste management facilities, remove recycling facilities from under these restrictions and instead regulate them as industrial materials facilities. Where recycling facilities are already regulated as industrial materials facilities, preserve the status quo. This designation for recycling facilities could be made through Federal, State, or local regulations.

Pros:

- Regulatory requirements, such as environmental impact statements, are typically more stringent for solid waste facilities. Regulating recycling facilities as industrial materials facilities will speed up program implementation.
- Redesignating recycling facilities may help remove some of the siting problems associated with solid waste management facilities.

Cons:

- Environmental risks associated with many recycling activities are relatively unknown and may vary with the type of materials handled. Thus, stricter environmental regulations may be desirable.
- May encourage "sham" recycling facilities to escape regulation as waste management facilities.

d. Federal and State transportation requirements should be studied to determine if any of those present substantial barriers to the transport of waste materials for recycling. Any inequities between the regulations for transporting virgin materials versus secondary materials should be examined.

Pros:

- A comprehensive understanding of transportation policies is essential to the consideration of substantially increased recycling nationwide.
- Transportation policies for virgin versus

secondary materials have not been examined since the 1970's.

Cons:

- The study will require some resources to perform.

e. Regional processing facilities should be established. These could be public, private, or joint public/private ventures.

Pros:

- Regional facilities help overcome processing, storage and transportation constraints facing many smaller recycling operations.
- Regional facilities are particularly beneficial in rural areas where volumes of recovered materials are so low that they fail to achieve the economies of scale required for optimum processing and transportation.

Cons:

- Regional facilities may have the disadvantage of being harder to site, because of the increased size of the facility.
- Agreement among several jurisdictions may be difficult to obtain, preventing development and siting of the facility.
- Allocating the sharing of costs and risks among the different jurisdictions is difficult.
- Gaining the cooperation of a multitude of governmental entities generally requires much more lead time, and a formal contractual arrangement between all parties.

4. MARKETS

As quantities of recyclables increase, markets will have to be in place to handle them. Policies to increase markets for recyclables will further promote demand for recyclables and ultimately serve to recover more of the solid waste stream.

a. Local, State, and Federal governments should issue and utilize procurement specifications for purchasing products made with recycled materials. Candidate materials include paper, compost, tires, steel reinforcing rods, rubberized asphalt, aggregate for roadbuilding, lubricating oil, reconditioned auto and truck parts, and various plastics products. Procurement guidelines should also address the purchase of products that are recyclable, rather than those that are not.

Pros:

- Because Federal and State governments have large operating budgets, they are generally perceived as large purchasers of materials. Thus, there is a direct effect on markets in terms of increasing demand. Currently, at least 18 States have some form of procurement legislation. Most of these laws deal only with paper, but some States have begun to target other materials, including tires and compost.
- A secondary effect is one of providing leadership in developing of recycling markets. The government serves as a model to others in purchasing recycling materials and tends to legitimize the whole concept of recycling as a reliable waste management technique.

Cons:

- These markets will require a certification program to verify compliance or noncompliance with purchasing guidelines.

- Federal purchasing guidelines are often not enforceable as regulations, but instead rely on voluntary compliance by government agencies.
- The uses to which the recycled materials will be put should be carefully evaluated to reduce any technical problems with the recycled materials (e.g., recycled paper in photocopy machines).
- Development of procurement specifications for materials having recycled content is a resource-intensive process and must be done carefully so that the desired results are encouraged/required by the guidelines (and not undesirable effects).
- Increased cost to government to buy these materials is likely if procurement guidelines merely result in a special market niche.

b. The Federal and State governments and industry should provide funds and conduct research and development for new products made from recycled materials. Research could be targeted at waste materials that present particularly severe waste management problems (e.g., tires, household hazardous waste, lead-acid batteries).

Pros:

- Provides new ideas and processes to increase the use of recycled materials in an end product.
- Funding research and development provides leadership to stimulate other recycling efforts.

Cons:

- The cost of such a research and development program may be high.
- Funding from the Federal and State governments is

subject to legislative appropriations and, thus may "dry up" unexpectedly if other priorities arise in the budget process.

c. The Federal government could conduct a market development study. Several States, including Michigan, Pennsylvania, and New Jersey, have undertaken extensive market studies to investigate ways of developing markets for recyclables. These studies point to the conclusion that no one market stimulus will help all the various markets, but that tax credits, research and development funds, interest loans and grants, all have a place in the strategy. The Federal market development study could address both domestic and foreign markets.

Pros:

- The proper approaches to developing markets throughout the country could be reviewed on a more comprehensive basis rather than relying on individual States to perform a succession of studies.
- The Federal market study can incorporate the work already done by some States.

Cons:

- Market development studies may be more appropriately done by regional organizations, because markets differ regionally.
- Such a large-scale study will require a substantial amount of time (several years) to develop and conduct.
- The cost of conducting the study, and then implementing recommendations, will be large.
- Such a study would require close cooperation between several different Federal agencies.

d. Requiring manufacturers to purchase recycled feed stock is another method of supporting end markets for recyclables. Here, producers would be required to purchase recyclables when available at a specified price based on an index of value of virgin materials. This could follow a format similar to that of the Public Utilities Regulatory and Policy Act (PURPA), where electric generating facilities are required to purchase energy from resource recovery plants at a market price, if available.

Pros:

- Helps to expand end markets for recycled goods.
- Increases commercial/industrial awareness on the need for recycling.

Cons:

- Difficult to decide which industries/commercial enterprises should be subject to this requirement.
- If conducted at the State level, a mandatory program may hamper industrial activity within the State, causing companies to move the plants/ businesses to States where no requirements exist.

e. Local, State, or Federal governments could institute price supports for secondary materials by guaranteeing a community or secondary materials broker a minimum price for a commodity. If market conditions change such that the price for a commodity falls below the minimum guaranteed level, the government would subsidize the difference.

Pros:

- Helps to stabilize end markets for secondary materials.
- Guarantees that the waste will have someplace "to go".

Cons:

- The effect of such subsidies on artificially changing market conditions is unknown.
- Funds for such price supports may be difficult to obtain, and predicting the funds necessary may be difficult, because of the sometimes rapid fluctuation in market.
- Could result in inefficiencies if price supports result in total costs for recycling that are greater than all other waste management methods.

f. Standardize the types of plastics to be used in certain products and packaging so that only a specified type of plastic could be used for those products.

Pros:

- This would improve the recyclability of plastics by making the separation process much simpler for consumers or recyclers.

Cons:

- It would limit the choice of manufacturers to use whatever plastics they think are appropriate in the product.

g. Regional marketing organizations should be established to share information on available secondary materials markets. These organizations could even be used as brokering organizations to market materials.

Pros:

- Pooling resources in the area of marketing will assist many of the smaller entities who do not have substantial marketing resources, or who do not generate large volumes of recyclables themselves.

- Regional brokerages will have increased leverage because of the volume of materials being marketed.

Cons:

- Regional brokerages, if publicly supported, may unfairly compete with private brokerage services.

5. INDUSTRIAL INFRASTRUCTURE

a. Industries should consider recyclability of the end product in designing new products and packaging. For example, a company could limit the different types of materials used in a product, or exchange the current material for other, more recyclable materials.

Pros:

- Considering the recyclability of a product in the design allows for easier recycling of the product when it is discarded.
- Raises corporate awareness of solid waste issues.
- Requires relatively little change in practice and probably little cost for companies to design for recyclability for new products.

Cons:

- Industries already have a list of factors that are considered in the design of a product (e.g., transport, distribution, marketing, product efficiency, cost). Designing for recyclability should not override these other factors, and thus, in practice, may never really occur.
- There may be technological reasons for not using more recyclable materials.

6. ENVIRONMENTAL RISK

a. EPA could conduct research to study the impact on the health of individuals working in recycling facilities, and any environmental impact of these facilities. For example, studies on facilities that recycle lead-acid batteries, de-ink newsprint, and recycle household hazardous waste would be helpful in assessing environmental and health risks.

Pros:

- o A research program would allow more informed decision making on the risks associated with recycling facilities.

Cons:

- o Costs of the program may be high, and uncertainty may still exist after the studies have been done.

b. Banning environmentally hazardous ingredients from otherwise recyclable material will benefit the recycling effort.

Pros:

- o By reducing the risk factor, the potential to recover more materials exists. Controlling the constituents in appliances, paints, and other components can reduce environmental hazards in disposing of shredded waste material.

Cons:

- o Costs associated with developing bans and enforcing them will be fairly high.
- o The basis for exacting such bans is not well-founded at this time.
- o Less toxic substitutes may not be available.

7. TAX AND SUBSIDY ADVANTAGES

Tax advantages provide a viable means to encourage waste recovery by giving advantages at all levels: manufacturing, consumption, and disposal.

a. Consumption tax credits would be credits accrued to businesses that consume recovered materials directly or consume products manufactured from materials recovered from the waste stream.

Pros:

- o Federal or State tax credits could provide economic incentive to recover more materials.

Cons:

- o Requires changes in tax codes, which can be a lengthy process.
- o At the State level, differences between State tax codes may cause industries and businesses to move from one State to another, perhaps decreasing or stalling economic growth.
- o May be difficult and resource-intensive to administer.

b. Investment tax credits to intermediate or end market facilities are another means that could be used to encourage waste recovery. The theory of this method is to facilitate the financing of new recycling businesses or the expansion of existing businesses by reducing the effective cost of financing. New companies may not have any tax obligations initially, so credits could be accumulated and carried forward for a time when they could be applied. Using accelerated depreciation schedules for new facilities would have the same effect that investment tax credits have. The difference is the mechanism by which the credits are claimed: either directly, as in investment tax credits; or indirectly, by rapidly depreciating the capital investments to defer more tax obligation in the early years of the facility or early life of new equipment.

Pros:

- Investment tax credits have been effective in States where they have been implemented.
- These tax credits may help to stabilize end markets for recycled goods, thus decreasing the amount of fluctuation in prices.

Cons:

- Changes in tax codes usually take a fairly lengthy amount of time to implement.
- Such tax incentives for recovery of materials may be counter-productive if the recovered materials are not actually recycled.

c. Property taxes and other State and local taxes could be lowered for businesses that utilize recovered materials.

Pros:

- Encourages commercial and industrial sectors to purchase secondary materials for their use, thus expanding the markets for such waste materials.

Cons:

- Preferential tax programs would have to be carefully evaluated in light of State and local laws.
- Loss of revenue results from this tax reduction; therefore, an increase in taxes on other entities or additional taxes of another type may be necessary.

d. A study should be performed to determine whether there currently exist any national tax policies that discourage the recycling of secondary materials.

Pros:

- o A thorough examination of national tax policies that encourage or discourage secondary materials recycling is necessary as part of any national program.

Cons:

- o Such a study will require some resources.

8. INFORMATION/EDUCATION

a. EPA could develop a standard method for monitoring public participation and materials recovered in recycling. This research should address both the level of participation in each recycling opportunity and the percent of material that is actually recovered.

Pros:

- o A standardized method for measuring success in recycling allows meaningful comparison between communities and encourages participation in recycling by allowing communities to set goals knowledgeably.

Cons:

- o A standardized method may overlook subtleties in a community's waste practices.

b. Study the uses of relatively homogeneous wastes from certain businesses and industry. Publicize the information developed on potential uses of these wastes.

Pros:

- Recycling markets may be identified for certain homogeneous wastes that were not earlier known to generators.

Cons:

- Such studies will require resources to conduct.

9. SOCIETAL INFRASTRUCTURE

Modifying societal infrastructure can have an impact on materials recovered from the waste stream. This involves means for changing the way consumers make purchases and the degree to which they are made responsible for the waste they generate.

a. One possible option is to mark products as recyclable, nonrecyclable, and made from recyclables.

Pros:

- The latter may have an important bearing after consumers have been educated and realize that there is no quality difference between products made from recyclables and those made with virgin materials.
- The impact of markings will increase as the value of recycling becomes an issue with consumers.

Cons:

- Labeling programs may be costly with little appreciable benefits in increasing recycling.

b. States and localities could mandate that new building construction must be designed with facilities for collection of recyclables. One complaint heard from many owners of businesses and apartment complexes is that space to store recyclables is unavailable.

Pros:

- If all building codes would allow for such activities, ample space would be available for recycling.
- Unique recycling problems associated with hi-rise buildings can be avoided.

Cons:

- Additional building code requirements would add to the existing enforcement burden on building inspectors.

c. Establish a National Recycling Council, with members drawn from industry, the Federal government, State and local governments, and public interest groups.

Pros:

- The Council could track trends in recycling practices, legislation, and markets.
- A highly visible leadership role is provided.

Cons:

- The Council would have little authority to make changes, but instead could only provide recommendations.
- The mix of members on the Council would have to be balanced carefully to represent all interests in recycling.

10. RECOVERY

a. Establish a program for commercial businesses and certain industries to separate recyclable materials. Commercial wastes, especially those of retail stores and offices, tend to consist of high percentages of paper products. For years, private waste haulers have used dump-and-pick operations to remove corrugated paper and other forms of waste paper from the commercial waste stream. The program could be a voluntary program with incentives such as good corporate image and publicity. Economic incentives to businesses and industry through reduced disposal costs can be a method of encouraging material separation in the commercial sector.

Pros:

- This type of program would lower the amount of commercially generated paper requiring disposal.
- Voluntary programs are fairly easy to implement at little cost, requiring the cooperation of wholesalers, retailers and distributors.

Cons:

- Voluntary program success is directly dependent on the cooperation and regular participation of organizations.
- Any new program to increase commercial/industrial recycling must carefully consider existing recycling activities.

b. Federal, State and local governments could mandate recycling by their governmental agencies.

Pros:

- An excellent example would be set for businesses, industry, and citizens to also recycle.
- Governmental organizations are a fairly large source of waste materials that could be recycled.

Cons:

- Local markets may not always be available; therefore, for Federal or State agencies, local flexibility in the type of participation may be necessary.
- Enforcement of a mandatory program may be resource-intensive.

c. Federal, State and local governments could pass laws that encourage voluntary recycling or mandate recycling by citizens, business, and industry. Voluntary recycling laws could set goals (as discussed in section 4A of this chapter). Mandatory laws could set goals and a means for enforcing these goals.

Pros:

- Mandatory laws provide enforceable mechanisms for meeting State or federal goals.
- Mandatory laws force local communities and citizens to address a comprehensive recycling plan, and highlight the importance of municipal solid waste management issues.
- Mandatory laws force public works officials, city managers, and waste handlers to address the role of recycling in managing MSW.

Cons:

- Mandatory laws can be fairly insensitive to regional differences in population, demographics, recycling feasibility, and market potential.
- Mandatory laws require a substantial funding mechanism for development of recycling. implementation plans and enforcement of the laws.
- Mandatory laws may result in lower quality of the recovered materials.

- Mandatory laws may hamper ongoing voluntary efforts, and the existing infrastructure for handling secondary materials.
- Without market expansion, mandatory programs may result in market gluts.

d. The Federal government could mandate that plastic products be coded by material type.

Pros:

- Coding would be beneficial in recovery of plastics for recycling. If the cumbersome task of sorting through different types of plastics could be simplified, a large portion of plastics now discarded could be salvaged. Recent voluntary efforts by the plastics industry in this area are encouraging.

Cons:

- Many multimaterial products would be difficult to code for accurate separation and recovery.
- Visual codes are useful for only handsorting materials. Codes that could be read by a machine would need to be developed.

e. The Federal government could pass "mandatory deposit" legislation that places a deposit on beverage containers so that they are returned to the point of purchase.

Pros:

- State laws of this type have been successful for recovering 80-90 percent of all beverage containers where in effect.
- Provides for a clean, high quality recovered material.

- Existing infrastructure is in place in some States.

Cons:

- State programs under these laws have had less success in actually marketing the returned materials.
- Such legislation covers less than 5 percent of the municipal solid waste stream and does nothing for the remaining 95 percent.
- The cost of overlaying the reverse distribution system costs consumers millions of dollars in those States where mandatory deposit legislation exists.
- Beverage deposit laws can remove profitable waste commodities (e.g., aluminum) from the local recycling effort by the community.

D. OPTIONS TO IMPROVE COMPOSTING

The potential for composting as a component of an integrated solid waste management program can be enhanced by significantly changing the current practices of solid waste handling and management. At present, marketing compost is difficult because of the uncertainty of its quality, the distance to potential markets, the potential for contaminants, and the availability of competing products. There are problems in siting compost facilities just as there are problems siting landfills and other waste processing facilities. There are also problems in funding composting facilities primarily because land disposal alternatives are still perceived to be relatively inexpensive. These problems have not prevented the implementation of yard waste or solid waste composting facilities, as demonstrated in chapter 2. Yet, to improve the opportunities of implementing an essential component of an integrated system such as composting, changes to the existing system must be examined.

1. MARKET DEVELOPMENT

Implementing yard waste composting, mixed solid waste composting, or composting facilities integrated with RDF systems is most often limited by a lack of revenue-producing markets. The problems inherent in marketing compost produced from waste include a lack of awareness by potential purchasers, a suspicion that contaminants are present or that the compost is of poor quality, the high cost of transporting compost to distant markets, and the availability of low-cost alternative products. Nonetheless, incentives to developing compost markets do exist.

a. Uniform Compost Specifications

Many potential markets have specific requirements and conditions for soil conditioners or soil amendments that could be replaced by compost. These markets are often concerned that compost offered for sale will not meet the needs of the purchaser because of word-of-mouth regarding inferior composts from low-budget facilities or past projects. Some facilities intentionally produce low-quality compost to avoid finishing costs and then offer the material at no or low cost. Because no uniform specifications on compost quality exist, potential markets are unwilling to pay a competitive price for a high-quality compost without sampling the material for a certain period of time. Uniform specifications would classify compost by grades to assure markets of the type of product they would be purchasing. Compost would be classified by particle size, moisture retention capability, nutrient levels, presence of foreign materials, and any other critical factors of concern to particular markets. Uniform specifications improve market and revenue potential by adding an element of consistency to compost marketing. Projects already in operation or even in the later stages of planning may be required to incur costs to provide a consistent compost that meets specifications.

Pros:

- Assures markets of a certain level of quality.
- Establishes pricing levels based on quality and provides long-term revenue planning.

Cons:

- Providing the periodic testing necessary to assure specifications can be costly.
- Existing facilities may incur costs to upgrade product.

b. Preferential Government Use

Legislative mandates or directives for government agencies to purchase compost produced from waste in preference to competitive products guarantee a sizable market for that product. Some States have attempted to address this issue. For example, Minnesota has an executive order calling for State agencies to use compost when feasible. Unfortunately, the order is not binding and is not expected to guarantee markets.

Pros:

- o Sets example to consumers, local governments, and businesses that the legislative body responsible for the order is attempting to overcome the problem of marketing compost.
- o Serves as a forcing mechanism for government agencies to become familiar with compost and its potential uses.
- o Assures markets, if directive is fully implemented.

Cons:

- o An assured market might result in a lack of incentive to produce higher quality compost.
- o The government would pay more than is necessary if lower-cost alternative materials are available but not purchased.

2. INFORMATION

a. Research

Compost produced from yard waste, mixed solid waste, and heavy fractions separated from waste going to RDF systems is a relatively new, unknown commodity in the United States. Because of this, many potential users have serious reservations about compost. Although it has monetary value compost is frequently given away because of these apprehensive markets. Testing compost and its performance in use over extended periods of time can provide an information base for directly comparing compost with competing products such as topsoil, peat moss, and bulking agents.

Research on the following subjects would be appropriate:

- Impacts of pesticides and herbicides on compost quality;
- Long-term results of compost addition to soils of various types and effects on vegetation;
- Long-term impacts of plant growth in various types of compost;
- Impacts of selected waste types in the composition of solid waste compost;
- Methods of standardizing compost classifications;
- Impacts of incorporating various agents (i.e., sludge, manure, etc.) into co-compost.

Pros:

- Can provide base information for entities planning compost facilities.
- Can provide information for market development by dispelling unknowns regarding compsot and its performance.
- Can result in greater cost-effectiveness for composting facilities.

Cons:

- Can be costly to conduct research.
- Results, in many cases may be indeterminate.

b. Information on Backyard Composting

Information should be developed and distributed to the public to promote backyard composting of yard waste.

Pros:

- Can increase backyard composting for yard waste, reducing both collection needs and large-scale facility costs.

Cons:

- Success may be difficult to measure.
- Developing educational materials and promotion of backyard composting may require significant resources.

3. INSTITUTIONAL ISSUES

a. Waste Flow Control

Waste flow assurance for composting facilities through regulations, ordinances or contracts may be necessary go garner financing for operating these facilities. Waste assurance differs from waste bans by providing supplies of waste through contracts or by ordinance rather than by regulatory bans. Waste supply contracts are negotiated between individual haulers and a unit of government to deliver waste to a processing facility. However, local governments typically provide waste assurance to garner financing for solid waste processing facilities. Assurance ordinances are often legally opposed by waste collectors who could contend that their costs would increase if delivery locations are imposed on them.

Waste flow control for compostable waste, such as leaves, brush, and grass clippings, would typically direct these wastes away from landfills or incinerators and to compost facilities. Bans on the placement of these wastes in landfills or incinerators can also result in an increase in backyard composting.

Pros:

- Provides appropriate supply of waste to a facility to be operated cost effectively.
- Can help in providing financing on better terms.
- Can stimulate backyard composting.
- Would reduce leachate and methane generation in landfills.
- Would improve energy value of waste directed to combustion facilities.

Cons:

- Separate collections or a means to segregate wastes at processing facilities would be necessary.
- Illegal dumping of waste may result.
- Would be difficult to implement.
- Ordinances and contracts may be difficult to enforce and may be legally challenged.
- May be politically difficult to implement.

4. FINANCIAL ASSISTANCE

Financial assistance from State or Federal sources could bolster the development of composting facilities. Assistance could be provided for actual construction and operation or for research on methods to improve the composting process or the quality of the compost itself. (See earlier discussion on Information/Research Options.)

State and Federal governments have limited resources to provide adequate financial assistance. Nonetheless, creative mechanisms are available to generate sources of funding for grants, research and other assistance. These include using funds generated from container deposits, landfill surcharges, taxes on noncomplying industry, etc.

a. Grants and Loans

Grants and loans provide working capital to assist the construction of composting facilities or to carry out research. Minnesota currently has a grant and loan program that provides up to 50 percent of all eligible capital costs for solid waste composting facility construction. The program has resulted in the construction of 2 facilities, with 10 or more in the planning stages. Such a program would also be effective at the Federal level. The Clean Water Act has a program for construction grants that has provided funding for sewage sludge composting facilities.

Both grants and loans are often provided after applications or feasibility studies are conducted. This process allows for adequate review opportunities that ensure workable projects. grants and loans are also typically provided with stipulations for long-term program monitoring and payback of funds if the projects are not constructed or operated according to the terms of the assistance.

Financial assistance in the form of grants and loans would also encourage landfill operators to promote composting adjacent to landfills. Compostable materials could be readily separated from incoming waste and the infrastructure for waste management activities would already be in place (e.g., truck access, scales, ground water monitoring).

Pros:

- Offsets high capital costs of facility or program implementation.
- Allows review and security of project feasibility.
- Provides impetus to waste management officials to consider such facilities.

Cons:

- Unsuccessful applicants could spend large sums to no avail.
- Funding for grant and loan programs may be difficult to establish and maintain.
- Administering grants and loans is resource intensive.

b. Landfill Surcharges

Landfill surcharges are fees placed on the disposal of selected materials to alleviate environmental damages or provide incentives for constructing land disposal alternatives. Surcharges allow collection of targeted materials (dry-cell batteries containing cadmium or mercury, herbicides, etc.) to continue but provide for revenue to cover the separation and special handling required for those items.

Pros:

- Provides incentives to avoid landfilling.
- Instigates alternative waste handling measures such as backyard composting of yard waste and large-scale composting.
- Can generate source of funds for landfill abatement measures.

Cons:

- Illegal dumping of waste may increas.
- May be politically difficult to implement.

5. SOCIAL CHANGES

Certain social changes may be necessary to enhance the use of composting of yard waste and other degradable organic wastes. The following options require individuals to take more responsibility for managing these wastes.

a. Backyard Composting

Individual homeowners would compost their own yard waste and perhaps other degradable wastes.

Pros:

- Individuals are responsible for managing their own waste.
- A material that is useful to the homeowner is produced from composting.
- Municipal waste management costs for degradable wastes are minimized.

Cons:

- Backyard composting is less convenient for the homeowner than refuse pickup.
- Rodents may be attracted to compost piles.
- Backyard composting is not possible for everyone because of a lack of space.

b. Yard Waste Separation

Individuals would keep their yard waste separate from their other waste so that it could be separately collected for processing at a large-scale compost facility.

Pros:

- Separation of yard waste by homeowners is essential to operating a large-scale facility for composting yard waste.
- Because of the way yard wastes are generated, they are often kept separate from other wastes by homeowners; i.e., little change in habits would be necessary.

Cons:

- Separating yard waste is less convenient for homeowners than not separating them.
- Collection of separated yard waste may increase municipal waste management costs.

6. REGULATORY

Regulatory options to improve composting address the obstacles of siting and environmental risk. Regulations can be initiated at the local, State or Federal level, with Federal regulation offering the best potential for uniform standards.

a. Product Bans

Banning certain materials from the waste stream entering compost facilities can reduce the potential for adverse impacts from the process itself or from the use of the finished compost. Materials that could be considered for banning include:

- Lawn herbicides and pesticides.
- Excessive nondegradable packaging. Separating plastics before and after composting is difficult and revenues

from marketing are lessened if nondegradable materials are present.

- o Nondegradable garbage bags. Bags are also difficult to separate from yard waste or solid waste before or after composting and may adversely affect market value.
- o Dry cell batteries. Mercury and cadmium can contaminate finished compost.
- o Heavy metal printing inks. Metals can contaminate finished compost.

Bans could include an outright restriction on use of the specified materials, but such restrictions would be difficult to implement unless justified by concerns other than composting impacts. Restricting specified materials or waste containing these materials from entry at compost facilities is a more likely alternative than banning their use.

Pros:

- o Compost quality would improve because of fewer potential contaminants.
- o Waste handling at the compost facility would be made easier.

Cons:

- o Data would be needed to substantiate bans.
- o Enforcement is difficult.
- o Illegal dumping of banned materials might occur.
- o Selecting materials for banning would be politically difficult.

b. Siting Requirements

Prerequisites for siting composting facilities can minimize or even eliminate citizen concerns. Requirements could include:

1. Minimum buffer zones, from neighboring houses and surface waters, depending on facility size and type of operations.

Pros:

- o Minimizes conflicts attributable to noise, odors, and visual concerns.
- o Protects surface waters fron runoff containing biological oxygen demand (BOD) contaminants.

Cons:

- o Space may not be available at all acceptable sites.
- o May add cost to facilities.

c. Permitting Requirements

As with siting requirements, permitting requirements could be issued at the local, State, or Federal level to standardize facility operations. Potential requirements could include:

- o Minimum monitoring requirements for the compost process (could include monitoring for temperature, bacteria, odor).
- o Minimum tests to be conducted on finished compost.
- o Collection and treatment of leachate and runoff from active composting areas.
- o Identification of controls to minimize odors, bacteria, etc.
- o Maximum time period for storage of unprocessed wastes.
- o Design requirements regarding pads or liners to underlie the wastes storage and processing areas.

Pros:

- These types of controls (and enforcement of them) would minimize public health and environmental impacts and enhance public acceptance of a site and of the finished compost product.

Cons:

- The cost of composting projects would be increased.
- Enforcing these requirements is resource intensive.

CHAPTER 4

OPTIONS TO IMPROVE MUNICIPAL SOLID WASTE MANAGEMENT

E. OPTIONS TO IMPROVE THE ROLE OF COMBUSTION

Options discussed in this section address the following areas:

Siting and Public Participation
  - Public education on MSW disposal options
  - Siting criteria and procedures standards
  - Level playing field
  - Incineration at Sea

Financing
  - Investment banking community
  - Financial assistance for planning stages
  - Loan guarantees

Institutional and Multijurisdictional Factors
  - Authorities or regional agencies
  - Local public bidding laws

Markets
  - Public Utilities Regulatory and Policy Act
  - Thermal markets
  - Ash disposal and reuse

Environmental Risk
  - Emission standards
  - Retrofit evaluations
  - Guidelines for enforcement
  - Toxics in the waste stream
  - Training

Tax Advantages

Lack of Information
- Information clearinghouse
- Technical database

1. SITING AND PUBLIC PARTICIPATION

a. Public Education on MSW Disposal Options

Credible information would significantly help decision makers, both for their own use in understanding the issues, and for educating the public. Sources such as EPA, major universities, the National Science Foundation, and so forth would be able to present the case for waste-to-energy as part of an overall strategy for solid waste management. Materials that would be of greatest interest include case studies of successful projects, facilities that are good neighbors, test reports, and case studies that illustrate how combustion fits into integrated waste management systems. Such materials should stress EPA and State agency oversight and monitoring roles that assure compliance with operations, maintenance, and training requirements. Additionally, evaluations of existing technologies and their application to the solid waste disposal needs of this country would help to dispel the notion that a simple, single answer exists.

Pros:
- Decision makers can plan MSW management based on the best available information.

Cons:
- Developing good, up-to-date information (particularly testing) is expensive. Also, the lack of uniform evaluation procedures makes

it difficult to develop good comparative information.

b. Siting Criteria and Procedures Standards

Siting criteria include both local factors and established technical principles (such as protection of wetlands, air emissions limits in nonattainment areas, and avoidance of floodplains) that can apply to all States. Consequently, although EPA can set minimum environmental standards for sites, state plans could add criteria addressing local concerns (such as protecting sport fishing areas). Because siting is often seen by neighbors as "unfair," or politically influenced, it is important to develop an impartial procedure for applying the criteria. Early participation in the screening and selection process by community residents adds considerable credibility to the siting process, and should be included in State plans.

Pros:

- Sound criteria and application procedures would ensure technically and politically supportable sites, facilitating project development.

Cons:

- None.

c. Level Playing Field

Regulations and enforcement for other waste disposal options do not require that these facilities carry their full "true" cost, including air emissions control, closure and postclosure for landfills, and so forth. Until society is paying the real cost for disposal, justifying the cost of waste-to-energy in comparison will be difficult. Very few data are available on the environmental effects of landfills

Landfill air emissions, for example, are limited primarily to information from California studies. The U.S. EPA is presently developing regulations for air emissions from landfills with a draft Notice of Proposed Rulemaking presently being reviewed within the Agency; it is scheduled for publication in November 1989 and final action in December 1990.

Pros:

- Better data on these options would assist informed decision making.

Cons:

- Testing to develop a database is costly.

d. Incineration at Sea

The increasing difficulties facing communitiess trying to locate waste combustion facilities have led to a number of proposals to build incinerators aboard ocean going vessels and carry the waste off shore to burn it. Proponents insist that the units would be designed to meet the same stringent standards that apply to on-shore facilities and that residuals would be returned to shore.

Pros:

- Would not have to locate in a community.
- Very little risk to human health from any air emissions.

Cons:

- Difficulty to provide environmental monitoring.
- Risk of spills or discharges.
- Opposition from ecological groups.
- Extra costs involved in storing, loading, and transporting waste and ash.
- Inability to recover energy.

2. FINANCING

a. Investment Banking Community

The financial firms involved in waste-to-energy facility projects have developed confidence in technologies proven over the years, and no longer consider them to be high risk projects. However, financial firms need four key project building blocks in place in order to be assured that the interests of potential bond holders are protected. First, waste-to-energy projects need reliable, long-term markets for steam and/or electricity. Second, bond holders need to know that the facility will not become environmentally obsolete--that standards will not change radically over time. Third, facilities need assurance that the fuel from a constant supply of MSW for meeting market contracts will be available. This means that planning for integrated waste management, including providing for source reduction and recycling, must be considered when designing waste-to-energy facilities. Finally, bankers must have documented data on the technical and financial reliability of facility vendors, including the designer, builder, and operator (which may be a single vendor).

Pros:

- Requiring a carefully structured project for financing results in a more stable, reliable project.

Cons:

- Requirements for proven technology and financial stability make it more difficult for new vendors or technologies to enter the market.

b. Financial Assistance for Planning Stages

Although the projects themselves can be financed through public or private bond issues, the planning process for these facilities is time consuming and costly to local governments. The burden is particularly heavy for smaller communities, because the planning process contains some fixed costs that remain the same no matter what the size of the ultimate facility. Feasibility studies, environmental impact statements, market development, siting, and vendor procurement and negotiations must all be accomplished at the same level of detail for any community. For a facility of 500 tons per day, the sponsor community (some 180,000 residents) can expect to spend a minimum of $2 million on planning. Although this is a small amount compared to the capital cost of a facility, it must be paid for directly from local tax revenues or a special bond issue.

Some States have instituted solid waste disposal taxes on tipping fees at disposal sites to raise revenues to assist local governments in their planning. When the people who use existing waste disposal services help pay for planning future waste disposal, local governments are relieved of some of the responsibility for raising new tax monies, and areas without adequate resources are assisted in developing responsible solutions to their MSW disposal problems. States should be encouraged to include such funding in their State plans; Federal technical assistance, grants, or loans would help in areas where State funds are not available. The bond issue used to finance the capital cost of the project can be increased to cover the repayment of these implementation funds.

Pros:

- Dedicated funds will encourage more and better planning at the local level.

Cons:

- Loans or grants require funds at the federal or state level.

c. Loan Guarantees

Interest cost is a significant part of the cost of capital-intensive facilities. A 1 percentage point drop in the interest rate is equivalent to a 12 percent drop in capitalized cost. A Federal bond guarantee (like loan guarantees for housing) would lower interest rates; however, the cost to the guarantor would be significant if a plant failed for technical or other reasons. Also, if an outside party is assuming financial risk for the project, there is less of a burden on the other parties to ensure that the project is technically sound.

Pros:

- Reduces financing costs to local residents.

Cons:

- Funds must be available, and careful planning is needed to ensure a viable project.

3. INSTITUTIONAL AND MULTIJURISDICTIONAL FACTORS

a. Authorities or Regional Agencies

In the past, local jurisdictions have often encountered difficulties in cooperating with each other on developing joint projects. Past history often intrudes, different political parties may be involved, the siting of a controversial facility in one jurisdiction or another can cause problems, and many other factors have hindered cooperation. One way of removing waste-to-energy projects from the potential political quagmire is to establish quasi-governmental authorities (such as the Northeast Maryland Waste Disposal Authority) or similar agencies with independent bonding authority. Another option is to make a larger regional jurisdiction, such as a county or even a State, responsible for waste disposal. Each State has a unique system of local jurisdictions and powers, and consequently, should adapt their State plans to encourage authority, agency, or county projects as appropriate.

Pros:

- Regional projects spread the nonfinanced costs over a larger group of taxpayers; create some economies of scale in the capital cost of the facility; use a single planning process rather than a number of them, thus reducing costs; enable larger agencies to hire specialized staff; and, reduce the vulnerability of authorities or agencies to public pressure and remove them from the political process.

Cons:

- Regional projects require higher hauling costs for communities at the greatest distance for the regional facility, and may have a potential for agency or authority insensitivity to local public concerns.

b. Local Public Bidding Laws

Under many State laws, local jurisdictions must accept the lowest bid considered responsive to the Request for Proposals. Other factors, such as the financial stability of the vendor, may not be considered. No waste-to-energy facility procurement is "off the shelf" or can be standardized by issuing specifications. Because of the long-term nature of these projects and their complexity, procurements generally require considerable negotiation with a selected vendor before a deal acceptable to all parties is struck. Consequently, it is critical that States provide mechanisms for procurements that allow other criteria in addition to lowest bid.

Pros:

- o Adoption of State legislation allowing negotiated procurements would remove an important obstacle.

Cons:

- o None.

4. MARKETS

a. Public Utilities Regulatory and Policy Act (PURPA)

PURPA was developed as a way of encouraging cogeneration and small power producers in the United States to supplement existing utility electrical generation capacity. The Act requires investor-owned utilities to purchase electrical power from cogenerators or small producers (such as small hydroelectric projects) at "avoided cost" rates. These rates are based on that utility's cost to produce equivalent new power capacity. Rates are developed under State boards or commissions of public utilities, and overseen by the Federal Energy Regulatory Commission (FERC). Many utilities have been reluctant to develop avoided cost rates that reflect the true cost of producing electricity. Also, some utilities resist including a capacity factor payment by overstressing the risk factors involved in waste-to-energy.

A recent FERC decision (Orange and Rockland case, April 14, 1988) threatens the stability of the small power producer market. In this decision, FERC reversed its own longstanding policy and overruled a New York State law that sets rates for cogenerated power above the level of actual avoided costs. The ability to sell electricity wholesale is a key element in the economic feasibility of waste-to-energy projects because of the role revenues play in long-term financing and the difficulties in securing long-term thermal markets. Strengthening PURPA to allow States to set attractive rates for waste-to-energy facilities as part of a State policy to encourage MSW combustion would allow this critical market to remain available. Several State Public Utility Boards are also considering instituting bidding systems for small power producers to supply needed new electrical capacity. This tends to drive costs down for utility rate payers but discourages waste-to-energy, which has a relatively high cost for electrical production (attributable to more elaborate emissions controls, and so forth) than other qualifying facilities. Renewed Federal support for avoided cost payment and Federal standards for what constitutes a "qualifying facility" are needed.

Pros:

- Stable electricity markets would encourage project development in areas where good thermal markets are unavailable.

Cons:

- Many interest groups (utilities, other small power producers) will resist special interest exceptions. Additionally, there is considerable resistance to PURPA in some States.

b. Thermal Markets

Long-term steam (or hot water) markets are difficult to find, and, if located, tend to lower the bond rating, because they are less secure than electricity markets. The bond market rating is pegged to the "weakest link" among the participants, so a B- or C-rated steam market weakens the overall bond credit rating. Federal loan guarantee or price support programs at the federal level could offset this weakness.

Nonetheless, district heating/cooling systems or industrial developments make excellent thermal markets. Requiring a life-cycle cost comparison of MSW combustion as an energy source to conventional sources as part of the building permit process at the local level could encourage such markets.

Pros:

- Federal or State support for district heating systems would benefit both waste-to-energy projects and local economic development efforts. Such systems also make the most efficient use of available energy sources.

Cons:

- Expanding existing Federal support for district heating (Department of Energy and Department of Housing and Urban Development) would require additional appropriations.

c. Ash Disposal and Reuse

Uncertainty about what constitutes proper disposal of ash or what reuse opportunities exist is delaying decisions on developing waste-to-energy facilities. Decision makers need clear direction or regulations from EPA. Proposed regulations are expected in December 1988, with promulgation expected in December 1989. Research in this field is vitally needed. Exploring reuse options is presently being jointly undertaken by EPA, the industry, universities, and State agencies. EPA should continue to take the lead and provide public information.

Pros:

- o Regulations would remove a major impediment and ensure proper ash management. Investigation of reuse options should assist in developing markets and further reduce landfill space requirements.

Cons:

- o None, unless regulations require excessively costly handling.

5. ENVIRONMENTAL RISK

a. Emission Standards

EPA emission standards for new facilities are expected to be issued in November 1989. Development of these standards will help reassure the public, local officials, State regulators, the investment community, and environmental groups that these facilities can be operated safely. The Agency is also preparing guidelines for the retrofit of existing facilities. Under Section 111.D of the Clean Air Act, such guidelines must be adopted as regulations at the State level as part of their State Plan, or if the State wishes to modify the EPA recommendations in the guidelines, then it must be able to justify the modification when EPA reviews the State Plan. Thus the EPA guidelines will have the force of law at the State level, and serve the same purpose of reassuring the public that existing facilities are being fitted with appropriate equipment and operated at the best possible levels.

It is likely that these EPA standards and guidelines will require regular testing for dioxins and furans, and continuous monitoring of specific operating parameters such as furnace temperature, carbon monoxide, and opacity. This will provide an ongoing data base in addition to startup testing for permits. Such test data will provide information for continued research in the field, and provide assurance that standards are being met.

Pros:

- Emissions standards for new facilities will make projects more feasible, guidelines for existing facilities will improve performance.

Cons:

- None.

b. Retrofit Evaluations

Retrofit of existing municipal waste combustors, including older, waste reduction only facilities, must be done on a plant-by-plant basis. Each plant represents a unique situation, including design, maintenance history, and remaining useful life. EPA regional offices should be trained to apply retrofit standards and assist States in achieving the degree and cost of retrofit appropriate for each facility.

Pros:

- Trained EPA regional office personnel will help States improve operating conditions and reduce emissions of existing facilities.

Cons:

- None.

c. Guidelines for Enforcement

For a facility to be acceptable to the public, local officials, the environmental community, and others, confidence that the facility is operated and maintained in conformance with design and regulations is essential. Additional monitoring by an outside agency, continuous monitoring, plus inspections by qualified, trained personnel are needed to provide assurance to the community.

Many State regulations do not spell out what happens when a facility exceeds its emissions permit limits. Can an upset condition continue for an hour while the operator gets the situation under control? Two days? West German regulations stipulate that if the upset is not corrected in 1 hour, the facility must be shut down. If not, the operator goes to jail. Federal regulations presently under development should spell out what actions States should take in enforcing emission limits.

Pros:

- Monitoring and inspections will increase community confidence in the safety of operating facilities, and ensure the lowest possible emissions nationwide.

Cons:

- Such measures will increase costs to the community, State, and/or Federal agencies. Additionally, some pollutants are harder to measure, making enforcement more difficult.

d. Toxics in the Waste Stream

Many individual components of the waste stream present problems in municipal incinerators, either as a source of air pollution, a pollutant of the residue, or because they are physically difficult to handle without causing damage to the incinerator or its components. Combustion controls and air pollution control devices can be used to minimize the production and/or release of some pollutants. However, even with effective air pollution controls, some pollutants (such as the heavy metals) are simply moved from one medium (the air) to another (the flyash). Therefore, consideration should also be given to keeping potentially hazardous items out of the incinerator.

Several levels of options can be considered for such items. These include a national ban on specific products or specific chemicals used in products, national deposits to reduce the amount of these products entering the waste stream, local restrictions on the disposal of specific items (provided that there is an alternative mechanism in place to handle them), mandatory or voluntary source-separation programs, and/or front-end separation at the incinerator prior to combustion. The specifics of these different approaches are discussed in detail elsewhere in this report.

As the major source of lead in the air emissions and residue, lead-acid batteries are the most obvious candidate for exclusion from incinerators. They have become more of a problem recently because recycling of batteries has been declining, and because they are now being sold more frequently over the counter to do-it-yourself consumers. A deposit or rebate system could be used to keep batteries out of the municipal waste stream. However, this would require setting up an infrastructure to receive, store, transport, and recover them. Restrictions on the disposal of batteries will also require ensuring that an acceptable alternate method exists to handle them. (A more detailed discussion on the options for handling lead-acid batteries appears in the Orphan Waste Section of this chapter.) Mass burn units are not presently designed to facilitate front-end separation; however, refuse-derived fuel (RDF) and modular incinerators could target batteries for either mechanical or manual separation prior to combustion. The cost and effectiveness of front-end separation of lead-acid batteries would have to be evaluated on a case-by-case basis.

Cadmium is also present in municipal waste in sufficient quantities to warrant consideration for exclusion. Like lead, it is found in both residue and air emissions. Unfortunately, it is present in many different products in small quantities, so the options outlined above for lead-acid batteries are not applicable. Instead, it will be necessary to look at the major uses of cadmium and determine whether substitutes exist either for the cadmium or the product. Sweden has successfully banned cadmium (except for NiCad batteries, for which no substitute yet exists), in all products manufactured or imported into the country.

Other metals appearing in the waste stream in smaller quantities include mercury, chromium, nickel, tin, silver, and zinc. Dry-cell batteries; inks and paints used in paper, fabric, and plastic products; metallic coatings; galvanizing; and solder account for the major sources of these metals. Substitution of less toxic materials (such as in printing inks) should be pursued wherever feasible.

Organics, in the form of chlorinated dibenzo-p-dioxins (CDD's) and chlorinated dibenzofurans (CDF's) have also been of concern in both the air emissions and the solid residue. Improving combustion controls and air pollution control technology forms the basis of current strategy for reducing these organic emissions. The possible sources of CDD's and CDF's are thought to include occurrence in their original form in the waste, formation from related chlorinated precursors such as chlorinated benzene and phenols, and formation from organic materials reacting with a chlorine donor. Although it would be impossible to eliminate all sources of dioxin from the waste stream, chlorine as the one common denominator in their formation, should be examined. It occurs primarily in polyvinyl chloride plastic products, bleached paper products, and food and yard waste. More research is needed on the sources and mechanisms of CDD and CDF formation.

Pros:

- Reduction of specific toxics in the incoming waste will reduce air emissions and toxics in ash.

Cons:

- Toxic reduction measures will result in increased cost (for developing alternatives); and possibly reduced performance of manufactured goods. For example, attempts to reduce the soluble lead content of printing ink can interfere with the recyclability of paper.

e. Training

Federal regulations for waste-to-energy facilities should contain requirements for operator training. Issues to be considered in developing a training program include: who should be trained, what level of expertise should be required, who should be responsible for training, and whether training would be mandatory or voluntary. The most cost-effective approach would be a uniform training program that all States would use, with centralized training provided at one or more locations. The cost of training and retaining trained operators could add to the overall cost of waste disposal. Although it is not appropriate for the Federal government to provide training, it should define the criteria, and perhaps underwrite the initial development costs. Training should culminate in certification and licensing of operations.

Pros:

- Properly trained personnel would result in improved operation of facilities and increased community confidence that facilities are responsibly operated.

Cons:

- Training would increase costs, both to the Federal government and the community.

6. TAX ADVANTAGES

The 1986 Tax Reform Act, particularly the cap on revenue bonds, had the effect of raising the cost of waste-to-energy facilities to local taxpayers. Given the enormous capital cost of these projects, and the critical service they provide, it would be appropriate for Congress to reconsider providing exception for such public purpose projects.

Pros:

- Tax incentives would result in reduced cost to communities, and encouragement of new projects.

Cons:

- Tax incentives would have a modest impact on Federal revenues.

7. LACK OF INFORMATION

The information problem is not entirely the lack of information, but the proliferation of misinformation as well. The options discussed above repeatedly call for information from a credible source. The first step is to provide currently available information; the second is to provide data on research efforts as they evolve. Such data sources would focus on the two types of audiences described below.

a. Information Clearinghouse

The target audiences for material from this source would be the educated layman (for example, local elected officials), the media, and the general public.

b. Technical Database

The waste-to-energy field is evolving rapidly. Research and test results are not now collected in any central source and coordinated. A key service that EPA could provide to the field is the tracking and sharing of information to the technical community, including industry, university researchers, State regulators, and the like. It is also important to exchange information with other nations that have made a major commitment to the combustion of MSW.

Pros:

- A central information source would reduce the controversy and confusion presently surrounding waste combustion issues, develop information needed to address continued improvement in performance, and help to bolster EPA's visibility and credibility in the eyes of the public.

Cons:

- This service, while providing necessary information to EPA, would require additional funds to disseminate.

CHAPTER 4

OPTIONS TO IMPROVE MUNICIPAL SOLID WASTE MANAGEMENT

F. OPTIONS TO IMPROVE LANDFILLING

As the dominant method of solid waste management, landfilling has also drawn the most attention from legislators and the public concerned about solid waste problems. The options that address some of these concerns can be grouped into three categories. The first group addresses specific obstacles identified in chapter 3; the second set covers technical and regulatory options; and the final group relates to specific components of the waste stream. In general, the issues addressed in this section do not overlap significantly with those addressed in the revised Subtitle D criteria currently under development, because those options and their evaluation will proceed under the formal rulemaking process.

1. SUMMARY OF OPTIONS

The three groups of options are:

a. Options To Address Obstacles

- Provide information about landfill operation
- Overcome unsuccessful local siting processes
- Federal/State siting on Federal/State lands for local use
- Encourage payments to host municipalities to facilitate siting
- Charge landfill users full capital, operating, closure, and post-closure costs
- Charge full costs through user fees
- Consider privatizing or contracting for landfill

operations

- Require regional solid waste planning
- Increase information transfer on energy recovery and contract development
- Provide PURPA-type incentives for landfill energy recovery

b. Technical and Regulatory Options

- Institute more stringent and aggressive enforcement of criteria
- Require training and certification for landfill operators
- Provide development and demonstration grants for emerging landfill techniques

c. Waste-Specific Options: Changing the Quantity or Characteristics of Individual Waste Stream Components

- Paper
- Glass
- Plastic
- Food and yard waste
- Tires
- Batteries
- Metals and white goods
- Combustion ash
- Sludges
- Household hazardous waste and small quantity generator waste

2. CRITERIA FOR EVALUATING LANDFILL OPTIONS

The criteria for evaluating these options address costs, human health and the environment, and implementation. For costs the major concern is that options contribute to recognizing and calculating the true costs of landfilling as a waste management option. A second cost issue is efficiency: landfill operators should minimize costs while still complying with applicable standards and regulations. While private landfills have the profit incentive to keep costs down, publicly owned landfills do not. The final cost issue is "who pays." The discussion of costs to implement some of these options should also consider who bears those costs and what difference that makes to the evaluation of the option.

The options should also contribute to minimizing landfills' impact on human health and the environment. Landfills will be a necessary component of solid waste management for the foreseeable future and, like other waste management strategies, landfilling is not risk-free. These options should work to minimize the full range adverse effects of land disposal, from traffic, noise, and litter to potential water and air pollution.

Finally, whether an option can realistically be implemented must be considered. For landfilling, the major constraints in implementing options will be public attitudes, budget constraints, and limited information about the impacts of alternatives, i.e., combustion and recycling.

3. SITING AND PUBLIC PARTICIPATION

Four options address problems with siting and public participation. Three involve increased Federal and State involvement and the last addresses incentives.

a. Provide Information About Landfill Operation

Siting a landfill places enormous demands on local officials who are faced with many difficult questions and an unhappy constituency. Technical information about landfill operation and effects can be used to describe how the unit will be designed and operated and how it will affect the community. Federal and State governments could collect and package this information for community leaders and citizens.

Pros:

- The broader perspective provided by outside information can show that the same issues and obstacles have been addressed elsewhere and that the problem is not isolated to one community, i.e., the community is not being "picked on".
- Outside information from a "disinterested" third party may lend credibility to local officials and their contractors, who are often accused of minimizing problems in order to accelerate siting and construction.
- Information can calm local citizen concerns. The ability to provide answers to questions in a readable, reasonable format may at least reduce citizens' uncertainty about aspects of the proposal.

Cons:

- Developing and distributing technical information requires funding and staff resources at either the State or Federal level

b. Overcome Unsuccessful Local Siting Processes

Local officials are subjected to a great deal of pressure and take substantial political risks when they are involved in contentious siting issues. Where local jurisdictions fail to select a site, a siting commission at the county, State, or Federal level could be granted authority to override local opposition by evaluating and/or selecting landfill sites.

Pros:

- The community would have a site for its landfill.
- A better site might result from a broader search.

Cons:

- The commission would require staff and financial resources to select and evaluate sites.
- Unpopularity with local residents could block its implementation.

c. Federal/State Siting on Federal/State Lands for Local Use

Federal and State-owned lands are widely dispersed around the country and some may be usable for landfills. These facilities could be privately operated, with government involvement limited to selecting and providing the site. This option would only be available where insurmountable regulatory or technical obstacles prevented siting on other lands.

Pros:

- Governments could control the siting decision and select environmentally desirable sites.
- Substantial economies of scale would result from large landfills serving many communities.
- Assures long-term care since a "responsible party" will be identified.

Cons:

- The State or Federal government would incur costs in the site selection process.

- The government would lose the option to use the land for alternative uses in the future.
- Federal involvement in the siting and development of a regional landfill would be politically unpopular.

d. Encourage Payments to Host Municipalities to Facilitate Siting

One way to overcome opposition to siting is to compensate the opponents for their inconvenience or hazard. This may involve providing property tax credits to residents or outright payments by surrounding communities to the community with the landfill.

Pros:

- It recognizes and quantifies the full cost of imposing the landfill on another community.
- It compensates those directly affected by the landfill.

Cons:

- The payments might be viewed as bribery of the community with the landfill.
- The payments may carry unpopular socioeconomic implications, e.g., wealthy communities paying to have less affluent towns take their waste.

4. FINANCING

The options to overcome financial barriers to improved landfilling all involve bringing the cost of landfilling up to its true cost.

a. Charge Landfill Users Full Capital, Operating, Closure, and Post-Closure Costs

Chapter 2 documents the wide disparity between true costs and reported costs, especially at publicly owned facilities. In many cases, operators are not even aware of the full costs of operating a landfill. Passing on full costs to users would eliminate this disparity.

Pros:

- Increasing the price of landfilling would reduce the amount of waste landfilled.
- It would also provide a basis for determining avoided costs from waste management alternatives that divert waste from landfilling.
- Higher costs could reduce landfill use and extend the lives of existing landfills, thus delaying costly siting and construction of new units.
- The costs would provide adequate revenue for the unit, even after it no longer accepts waste, e.g., for monitoring and post-closure care.

Cons:

- These substantial advantages would come at the expense of "rate shock" for some users, however. The magnitude of the increase could adversely affect residential and commercial users through tax hikes or increases in other fees.

b. Charge Full Costs Through User Fees

An alternative means for collecting full costs would be to charge users directly. Instead of paying a higher annual fee or higher taxes, users would directly pay higher costs per bag or per truck load; this would provide the sole source of revenue for the landfill.

Pros:

- User fees would reduce waste generation even further because the cost impact falls directly on generators.
- Removing subsidies from general funds would force the landfill to be financially self-sufficient.
- Removing waste disposal operations from local budgets would allow landfills to operate as independent authorities.

Cons:

- User fes may encourage illegal dumping.
- Local citizens would have a solid waste bill to pay in addition to their property taxes. Solid waste costs that were tax deductible when included with property taxes would not be so under this option.

Although tax deductibility is a real concern, communities have overcome this issue over the past 10 years with regard to sewage treatment systems. Costs for these systems were also once part of the municipal budget, but through regulation and guidance virtually all of these systems recover full costs from their users.

c. Consider Privatizing or Contracting For Landfill Operations

When landfills are run for profit they must pass through full costs to users.

Pros:

- Private landfills have the incentive to improve the efficiency of their operation to lower costs and increase profits.
- Privatization would encourage full-cost accounting.

Cons:

- Local governments would lose some control over the operations and procedures at the landfill.

5. INSTITUTIONAL BARRIERS

The thrust of the options to overcome these barriers is to encourage regional cooperation to reduce total costs. The four siting options mentioned above would all encourage regionalization.

a. Require Regional Solid Waste Planning

In addition to these siting options, the Federal government could require regional solid waste planning similar to water quality planning under section 208 of the Clean Water Act.

Pros:

- Communities would enjoy reduced landfilling costs because of greater economies of scale.
- It would force broad, long-term waste planning.
- It would broaden the search area for desirable locations for landfills.

Cons:

- It adds another layer to the already complex landfill planning and siting process.
- It requires substantial funding.

- Planning under section 208 was not very effective in establishing implementable programs given the cost and effort required to prepare 208 plans.

6. MARKETS

Markets do not pose the same obstacles to landfilling that they do for materials recovery, but they do affect energy recovery. One approach for improving the economics of landfills is to increase the amount of energy recovery.

a. Information Transfer on Energy Recovery and Contract Development

Landfill gas recovery is reasonably widespread and communities have made arrangements so that they can benefit from these projects.

Pros:

- At some landfills, energy recovery would help landfill operators offset some of their costs.
- Gas recovery would also mitigate problems caused by unwanted migration of landfill gas.

Cons:

- Gas recovery is not viable at all landfills.
- Developing and distributing this information would be expensive.

b. Provide PURPA-Type Incentives for Landfill Energy Recovery

Under PURPA, energy supplied from nonconventional sources is bought by utilities for a price determined by the utilities' avoided cost of generating that power. Currently, methane gas recovery from landfills is not included under PURPA. Therefore, landfill owners who want to sell gas must negotiate with gas pipeline companies that are not required to take the gas in the first place or to establish a basis for setting the selling price.

Pros:

- Including methane gas in PURPA would define these boundaries and greatly enhance the market and revenue potential for selling landfill gas.

Cons:

- This option may encounter opposition from utilities.

7. TECHNICAL AND ADMINISTRATIVE OPTIONS

These options were designed to avoid overlap with issues already addressed in the upcoming criteria revision, but several options treat related topics, including enforcement and operating practices.

a. Institute More Stringent and Aggressive Enforcement of Criteria

States and the Federal government should increase their oversight and enforcement of the design, construction, and operation of landfills. This could involve assigning personnel to observe these different stages or requiring certification of these activities by the landfill owner at various stages of the project. All three components are important in assuring that landfills meet the criteria.

- In the design stage, enforcement officials could review plans to ensure that the siting and design will meet standards.

- Construction oversight ensures that the builder conforms with the design and that appropriate materials and components are used.

- During operation, enforcement officials would monitor the practices at the landfill and the performance of the design features, e.g., monitoring wells, leachate, and collection system.

Pros:

- Landfill operators and regulators gain credibility with the public, a major barrier to siting and to continued operation at existing landfills.
- Enforcement could prevent of violations that would adversely affect human health and the environment.

Cons:

- The enforcing government must devote resources to develop procedures and hire staff.
- Trained, technical staff may be in short supply, especially for governments that generally do not offer compensation competitive with the private sector.
- Delays in any phase of the project cost the owner and contractors time and money.

b. Require Training and Certification for Landfill Operators

The revised criteria and the public awareness of potential landfill hazards place a premium on the safe operation of landfills. Operator responsibilities continue to increase, given the upcoming requirements for screening incoming waste and working in some cases with complex designs (e.g., running equipment over liner systems, operating leachate and gas collection systems, and installing and sampling from monitoring devices). This training would be part of the cost of operating a landfill.

Pros:

- Like increased enforcement, operator training and certification would improve public credibility.
- It would also decrease the risk of damage to the environment and human health.

Cons:

- The cost of training would translate into higher landfilling costs.
- A potential shortage of certified operators would block this option.

c. Provide Development and Demonstration Grants for Emerging Landfill Techniques

Research into the design and operation of landfills improve their overall operation and minimizes their impact on the environment. Issues such as "high and dry" vs. "low and wet" are basic to whether landfills should be viewed primarily as repositories or treatment facilities. Some aspects of this research may be helpful at a national level, while others may be directed more to specific States or regions. The focus of the research could determine the appropriate source of funding.

Pros:

- Research would produce more effective designs.

- Research would promote better operating practices.

Cons:

- This option requires staffing and budget at the Federal level to oversee research and allocate resources.

8. WASTE SPECIFIC OPTIONS: CHANGING THE QUANTITY AND CHARACTERISTICS OF INDIVIDUAL WASTE STREAM COMPONENTS

Options to improve landfilling also include the efforts to reduce the overall cost and adverse effects resulting from the land disposal of particular components of the waste stream. Landfilling less material and less toxic material are two ways to achieve these reductions. Incineration is a related option that substantially reduces both the weight and volume of solid waste. Another option is to divert wastes from landfills through source reduction, recycling, or alternative processing and disposal methods. Diverting waste from landfills or modifying its characteristics, however, has both pros and cons. Moreover, there are specific advantages and disadvantages that apply to each of the various components of the waste stream.

a. Paper

Paper and paperboard products are the largest single component of the municipal solid waste disposed of in landfills, representing 41 percent of the total (by weight) and 50 percent (by volume). The decomposition of paper in landfills is also very slow, so the largest component of the materials landfilled does not degrade rapidly and, therefore, is using up valuable landfill capacity. Reducing the amount of paper landfilled is a very desirable option to preserve capacity. This reduction is achievable and economically desirable for certain paper through source reduction, recycling, and combustion. The negative factors associated with reducing waste paper disposal are the same factors discussed in earlier section of this chapter for fostering source reduction, recycling, and combustion.

b. Glass

Glass accounts for 8 percent of the municipal solid waste stream, yet is inert and does not pose an environmental problem in landfills. The principal motivation for removing glass from landfills is that it uses up capacity and degrades very slowly. The principal option for reducing glass in landfills is recycling and using returnable glass containers. The pros and cons of glass recycling are discussed earlier in the chapter.

c. Plastics

Plastics are a growing component of the waste landfilled, accounting for 7 percent (by weight) in 1986. To preserve capacity, recycling of plastics is a desirable option, as discussed earlier. Degradable plastics are also being developed to address litter problems. The behavior of degradation products in landfills is not well studied. One option is to conduct more research into the landfill byproducts of degradable versus nondegradable plastics.

Pros:

- More research would answer questions about the proper management of plastics and the benefits of enhanced degradability.

Cons:

- Research would be expensive, and test results might have limited applicability for actual landfills.

d. Food and Yard Waste

Food and yard waste account for 29 percent of municipal solid waste. Food waste accounts for 9 percent and is probably best disposed of in landfills, as it is not well suited for composting and has a low heat value for combustion. Food waste does contribute to the biological and chemical oxygen demand in leachate.

Yard waste makes up one-fifth of municipal solid waste; removing it from landfills would significantly extend landfill capacity. The best alternative for yard waste is composting. The pros and cons of composting projects are described earlier in the chapter.

e. Tires:

Tire disposal in the United States is an enormous problem. Many municipal solid waste landfills do not accept tires because they are high in volume, difficult to handle, harbor rodents, cause uneven settling, and tend to "float" to the surface of landfills. Some landfills shred tires before landfilling, which minimizes handling problems, but is very expensive to operate.

An alternative is to ban tires from all landfills and correct the problems associated with giant tire dumps by requiring their incineration of tires reusing or recycling them in road construction or other applications. In either case, only tires that have exhausted their useful life (i.e., have been recapped if possible) should enter the waste management system.

f. Batteries

Virtually all household batteries are discarded into the waste stream. The major concern over batteries in landfills is their potential for generating leachate contaminated with constituents such as mercury, cadmium, and zinc, although no evidence currently links batteries to these constituents in leachate.

One option for removing batteries from the waste stream is to establish a battery collection program using deposits or some other mechanism.

Pros:

- Battery recycling would enable metals to be recovered from batteries.
- Removing batteries from the waste stream would reduce the potential hazard from metals in leachate.

Cons:

- Increased costs would result from battery disposal in hazardous waste facilities.

Another option to consider is the increased use of rechargeable batteries to reduce disposal. This option would require incentives to alter the current economics of rechargeable versus disposable batteries.

Pros:

- Rechargeable batteries result in reduced waste volume.
- They reduce the potential hazard from metals in leachate.

Cons:

- Expense and market disruption if incentives are employed to increase the use of rechargeable batteries.

g. Metals and White Goods

Metal wastes contained in municipal solid waste consist of containers, white goods, scrap metal, and metal electrical components. These materials account for approximately 7 percent of municipal solid waste. Metal wastes therefore use up disposal capacity when they could be recycled. These wastes also contribute to the presence of heavy metals in leachate as the metals oxidize in the acidic landfill environment. These problem from disposal of metals could be addressed by increasing recycling and reuse. The pros and cons of recycling these products are discussed earlier in the chapter.

h. Combustion Ash

Combustion greatly reduces the volume (by 90 percent) and weight (by 75 percent) of municipal solid waste. Yet, even when waste is burned, the remaining ash still must be landfilled. The concern about ash disposal in municipal solid waste landfills is the generation of leachate that may contain potentially hazardous constituents from the ash.

The options for changing current practices are to treat and/or recycle the ash and to construct secure monofills for ash. Treatment methods are available to encapsulate heavy metals in ash to prevent leaching. Ash can also be used as a construction material, providing a substitute for sand and gravel. The advantages and disadvantages of these options need further study, as discussed earlier in the chapter.

i. Sludges

Wastewater and nonhazardous industrial sludges are frequently disposed of in municipal landfills. This is an acceptable practice, given compliance with applicable regulations. In addition to using up capacity, however, sludges can pose management problems for the landfill operator because of high water content. In particular, very wet sludges are difficult to transport, can bog down compacting equipment, and they inhibit effective mixing with the other waste. The water content of sludges also encourages the generation of leachate, and the constituents of some sludges have the potential to increase the concentration of metals and organics in that leachate.

One option to reduce the potential for leachate generation is to set requirements for maximum water content levels for sludges. In order to address potential hazards from leachate constituents, Federal or State governments could establish criteria for the constituents in landfilled sludges.

Pros:

Both of these options would

- Reduce transportation costs and disposal fees for generators.
- Improve the physical characteristics of landfilled waste.
- Reduce the potential hazards from leachate.

Cons:

- Sludge generators would incur increased costs to control their waste streams and to process their sludges.

j. Household Hazardous Waste/Small Quantity Generator Waste

Household hazardous waste makes up less than 1 percent of total municipal solid waste. It does not pose capacity problem, but it does pose problems for leachate and air emissions because of the nature of the waste constituents. Many communities offer specific collection programs for this waste to remove it from landfills. Many examples of these collection programs exist, so that many communities have experience with local collection programs for household hazardous waste. Communities that bid disposal or collection contracts could also include requirements for collection days for these wastes.

Pros:

- Special collection programs reduce the potential hazards from air and water emissions from landfills.
- They impose consistent requirements on communities so that these wastes are not concentrated in a few municipal landfills.

Cons:

- These programs are expensive to establish because the collection is costly and the ultimate disposal of the materials in hazardous waste facilities costs much more than landfilling in Subtitle D units.
- Enforcing voluntary programs for hazardous waste collection is extremely difficult.

Small quantity generator waste is banned from municipal solid waste landfills, but waste from "very small quantity generators (VSQG's)," those that generate less than 100 kilograms per month are not covered by Subtitle C of RCRA. Some of this waste is landfilled and may be released to the environment. Establishing collection programs for very small quantity generator waste is one option, but as with household hazardous waste, it is very expensive.

CHAPTER 4

OPTIONS TO IMPROVE MUNICIPAL SOLID WASTE MANAGEMENT

G. ORPHAN WASTES

1. CAR BATTERIES

a. Regulatory Options

(1) Ban from landfills and incinerators
(2) Require manufacturers and retailers to "buy back" all batteries
(3) Require a deposit on all new batteries
(4) Require a manifest system to keep track of batteries
(5) Relax hazardous waste requirements for battery recyclers
(6) Require manufacturers to conduct research to find safer substitutes for lead

b. Regulatory Mechanisms

(1) EPA-imposed and enforced regulations
(2) Require States to regulate and enforce
(3) EPA model regulation, adopted and enforced by the States

c. Non-regulatory Options

(1) Subsidize battery recyclers
(2) Underwrite health and environmental liability of recyclers
(3) Stimulate markets through procurement policies
(4) Training on how to operate safe and efficient battery recycling operations

2. TIRES

a. Regulatory Options

(1) Deposit or "buy back"
(2) Require tires to be shredded
(3) Require manifesting system

b. Regulatory Mechanisms

(1) EPA-imposed and enforced regulations
(2) Require States to regulate and enforce
(30 EPA model regulation, adopted and enforced by the States

c. Non-regulatory Options

(1) Procurement
(2) Encourage R&D on uses of shredded tires
(3) Subsidies for R&D and for shredders

1. CAR BATTERIES

The following are options that are intended to increase the amount of recycling of car batteries:

a. Regulatory Options

(1) Ban from landfills and incinerators.

Pros:

- Would keep batteries out of landfills and incinerators.
- Would indirectly encourage recycling.

Cons:

- Would not deal with the dumping and "store forever" problem.
- Would have little impact on landfills and incinerators because most of them will not take batteries anyway.
- Would be difficult to enforce.

(2) Require manufacturers and retailers to "buy back" all batteries.

Pros:

- Would provide incentive for batteries to be returned, rather than dumped by consumers and retailers.
- Would presumably result in greater recycling.
- Would provide incentive for industry to find cost-effective ways to recycle.
- Would internalize the disposal costs at the manufacturing level.

Cons:

- Could be very expensive, thus putting some companies out of business, or raising the cost of batteries.
- Would be difficult to enforce.
- Would not necessarily result in increased recycling if other options, such as landfilling or illegal dumping were less costly.

(3) Require a significant deposit on new batteries which would be returned when the battery was returned.

Pros:

- Same as for "buy back", except that a deposit would also provide an incentive to the consumer to return the battery (a "buy back" would allow manufacturers to collect a deposit, if they chose to do so).
- Would promote scavengers.

Cons:

- Would raise the cost of batteries.

(4) Require a manifest system to keep track of batteries returned under a deposit or "buy back" system.

Pros:

- Would provide a method for keeping track of each battery.
- Would presumably result in greater compliance.
- Would be easier to enforce.

Cons:

- Would be expensive.
- Would create another paperwork burden for the industry.
- Would still be difficult to enforce, especially against smaller companies.

(5) Relax hazardous waste regulations for smelters and other recyclers.

Pros:

- Would make it less expensive for them to recycle batteries.

Cons:

- Could result in greater environmental and health problems than landfilling or incinerating batteries.

(6) Require battery manufacturers to do research on safer substitutes for lead in batteries.

Pros:

- Could result in safer disposal for batteries, if a substitute is found.
- Could be less costly than either a "buy back" or a deposit system, if a substitute is found.

Cons:

- Could be costly.
- Finding a suitable substitute for lead will be difficult.

b. Regulatory Mechanisms

(1) EPA-imposed and enforced regulations.

Pros:

- Consistency, nationwide.

Cons:

- Difficult to enforce federally.
- May interfere with local MSW activities.

(2) Require States to regulate and enforce.

Pros:

- Maintains local control.

Cons:

- Interstate commerce concerns because of inconsistency among states.

(3) EPA model regulation, adopted by States.

Pros:

- Consistency
- Maintains local enforcement.

Cons:

- May not allow for differing needs among States and localities.

c. Non-Regulatory Options

(1) Subsidize secondary smelters and other battery recyclers through tax guarantees, direct payment, tax credits, etc.

Pros:

- Would result in greater recycling.
- Could result in waste management savings in both disposal and clean-up.

Cons:

- Could be costly.
- Could create too much dependence on the part of industry.

(2) Underwrite health and environmental liability of secondary battery handlers.

Pros:

- Would make recycling more attractive for recyclers.
- Could establish conditions for underwriting which would protect the environment.

Cons:

- Could result in failure of recyclers to protect the environment because they were not accountable.
- Could be costly.

(3) Stimulate markets for batteries made from recycled batteries, through procurement policies.

Pros:

- Could help sustain and expand markets for batteries made with recycled content.

Cons:

- Could have no real impact on the viability of the industry.
- Could be more costly to the procuring agencies.

(4) Training on how to efficiently and safely operate secondary battery operations.

Pros:

- Could improve the operation of these plants so they could function more profitably and safely.
- Could stimulate new practices and operations.

Cons:

- Training may not be the major problem; it just may not be a profitable industry.
- Would be costly.

2. TIRES

a. Regulatory

(1) Deposit or "buy back" by tires and retailer.

Pros:

- Would provide incentive for batteries to be returned, rather than dumped by consumers and retailer.
- Would presumably result in greater recycling.
- Would provide incentive for industry to find cost-effective ways to recycle.
- Would internalize the disposal cossts at the

manufacturing level.

Cons:

- Could be very expensive, thus putting some companies out of business, or raising the cost of tires.
- Would be difficult to enforce.
- Would not necessarily result in increased recycling if other options, such as landfilling or illegal dumping were less costly.

(2) Require that tires be shredded.

Pros:

- Would put tires in form best suited for waste management.

Cons:

- Would be costly.
- Would be difficult to enforce.
- Would make disposal more costly, thereby making illegal dumping even more economically attractive.

(3) Require a manifesting system.

Pros:

- Would keep better track of tires, thereby reducing illegal dumping.

Cons:

- Would create paperwork on 200 million tires per year.
- Would be difficult to enforce.

b. Regulatory Mechanisms

(1) EPA-imposed and enforced regulations.

Pros:

- Consistency, nationwide.

Cons:

- Difficult to enforce federally.
- May interfere withlocal MSW activities.

(2) Require States to regulate and enforce.

Pros:

- Maintains local control.

Cons:

- Interstate commerce concerns because of inconsistency among states.

(3) EPA model regulation, adopted by States.

Pros:

- Consistency.
- Maintains local enforcement.

Cons:

- May not allow for differing needs among States and localities.
- Federal oversight would be costly.

c. Non-Regulatory Options

(1) Stimulate markets for retreaded tires or products made

from recycled tires by procurement policies.

Pros:

- Could help sustain and expand markets for used tires.

Cons:

- Could have no real impact on the viability of the industry.
- Could be more costly to the procuring agencies.

(2) Stimulate markets by sponsoring and otherwise encouraging research into uses and technologies for sliced tires.

Pros:

- Would help create markets for both recycling and incinerating shredded tires.
- Would provide a visible research agenda which would minimize duplication and encourage entrepreneurs to enter the field.

Cons:

- Could be costly.

(3) Subsidies for R&D and for shredders.

Pros:

- Would provide greater stimulus for the program.

Cons:

- Would be very costly.
- Would not be keeping the costs where they are explicitly paid by the citizens.

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CHAPTER 4

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CHAPTER 5

RESEARCH, DEVELOPMENT, AND DEMONSTRATION

INTRODUCTION

The nation's mounting problem of how to effectively manage municipal solid waste necessitates reevaluation of MSW practices and identification of new technologies for waste disposal. The alternative MSW practices relating to source reduction and recycling should be evaluated to reduce the amount of residuals for disposal; conserve raw materials and land disposal facility capacity; and to reduce the cost for waste management. New technologies for waste disposal associated with combustion, landfilling, and composting should also be investigated to ensure that human health and the environment are protected. Institutional issues will need to be addressed as they relate to incentives and impediments to these practices. The risks associated with existing MSW practices will have to be assessed and compared as many questions remain regarding adequate monitoring of emissions and other releases from MSW facilities.

Pertinent R&D can be done by states and the private sector as well as by the Federal government. Generally speaking, development and commercialization of new technologies is the role of the private sector, whereas the roles of the Federal and State governments are to evaluate and encourage technology development, conduct technoeconomic studies to assess needs and markets, develop risk analyses and monitoring methods, conduct generic risk assessments, and to gather, organize, and disseminate information through an aggressive outreach and technology transfer program.

MITE PROGRAM

The Office of Environmental Engineering and Technology

Demonstration at EPA is proposing a program called the Municipal Waste Innovative Technology Evaluation (MITE) Program. This program will be structured similarly to EPA's successful SITE (Superfund Innovative Technology Evaluation) program for developing and demonstrating innovative Superfund cleanup techniques. In conjunction with technology developers, EPA will sponsor demonstrations of new MSW management technology and techniques to accomplish the following goals:

- Provide up-to-date cost/effectiveness and environmental information to local decision-makers on innovative new equipment and techniques for managing wastes. There currently is no mechanism or program that fills this need.
- Accelerate commercialization of new privately developed equipment and waste management techniques by sponsoring early demonstrations. Currently, there is resistance to first time use of new and unproven technology.
- Provide support and lend credibility to new techniques and equipment being developed at the bench- and pilot-scale so as to foster development of improved product substitution, recycling and recovery, waste treatment, and disposal technology.
- Develop promising techniques directly (through contracts and grants) where a definite need exists and the private sector is not responding.
- Develop guidelines for use by city managers and engineers which will provide methodologies to allow them to evaluate the risks and cost-effectiveness of various disposal options.

The following sections identify the major unanswered questions in the MSW field that warrant R&D attention on a national basis. These derive from recent symposia and discussions with experts. It is probably not a comprehensive list but is thought to contain the major areas warranting work. Developed technologies in these categories might be demonstrated through the MITE program.

A. SOURCE REDUCTION

Source reduction includes activities designed to reduce the generation of materials which require ultimate disposal. Source reduction programs in the past were often impeded by the lack of commitment of the public, lack of knowledge about the subject by the public and industry, and/or poor economics.

The best opportunities for improving this situation and increasing source reduction successes will involve increasing the knowledge and commitment of the public and the industrial/commercial segment. Industry will need to consider and implement process changes to improve efficiency and reduce the amount of waste. This will also involve the reevaluation of the materials they use so that waste generated at the plant level can be reintroduced back into the production stream as the feedstock of another product.

Potential areas of research to improve source reduction include:

- o Assess new chemical concepts of utilization of waste plastics.
- o Investigate the biodegradability of packaging plastics, including the toxicity of the products of decomposition.

These areas may be best investigated by the plastics industry.

B. RECYCLING

Recycling has been underutilized as a solution for minimizing the amount of MSW which needs to be disposed. Recycling has many aspects, including separation, collection, processing, marketing, and waste utilization. Plants have been built with complex separation/sorting hardware and approaches that were fraught with technical/mechanical problems and questionable economics. When recovery was successful, the recovered materials often had limited marketability. Since landfilling was frequently the cheapest alternative, the recycling industry did not experience its expected growth.

Therefore, the research, development, and demonstration activities needed to enhance recycling include:

- Update the state-of-the-art in front-end separation techniques.
- Evaluate the current status of recycling programs in the U.S. in the form of case studies with emphasis on success stories, and evaluate the economic and market factors that made these programs successful.

State and/or local governments, with the help of EPA, will be able to perform this second activity which will basically consist of researching various localities and states for successful recycling programs and making an assessment as to the economic/market incentives that keep these programs successful. An update of the status of recycling programs is long overdue and can be accomplished in a relatively short period of time.

- Evaluate the status of household separation and other separation/collection programs and the economic and market incentives of these programs (case studies).

Those separation/collection programs that have been successful need to be highlighted and lessons learned communicated to other cities.

- Reassess potential for new markets and identify impediments to recycling (i.e., glass, paper, shredded tires).

By providing new markets for recycled materials, the amount of solid waste disposed of in landfills and incinerators, would be decreased.

- Update previous work on effects of beneficial freight rates for secondary materials.
- Develop ways in which to upgrade deinking technology for the removal of contaminants from a wide variety of paper grades.

C. COMPOSTING

Composting of MSW has met with only limited success due to the lack of economic incentives to make it competitive with other products for use as a soil conditioner. Composting is most commonly used for yard waste, however, interest in composting of solid waste and RDF residuals is on the increase. Improved techniques for accelerating the degradation process as well as additives to enhance the final material could improve the value of compost to offset marketing problems.

The following research, development, and demonstration activities for composting include:

- Develop product quality standards for composting that would form the basis for developing a market for compost.

- Assess environmental benefits of not collecting grass clippings considering the soil conditioning benefits of the clippings as well as the potential problems that herbicides and pesticides on the clippings pose in the composting process.
- Evaluate full-scale operation of an existing MSW composting facility.

The first of these recommendations would involve a standards-setting group of experts. All of these proposed research projects should involve the Department of Agriculture.

D. COMBUSTION

The combustion or incineration of MSW has been a widely practiced technology for many decades. However, a significant amount of research is necessary to fully develop and establish effective pollution control technologies for the reduction of air pollutants from flue gases, and to develop better combustion technologies to minimize the formation of these constituents in the first place. There are also significant questions regarding environmental impacts of ash disposal and use. The following research will address these issues:

- Characterize and evaluate pollution control technologies at full-scale mass burners and RDF plants equipped with CaO spray dryers/fabric filters, ESPs, and wet- and dry-scrubbers for dioxins/furans control. This work is currently ongoing at EPA, and should be continued.
- Evaluate emissions and control options for full-scale modular combustors and fluidized bed combustors that burn MSW.

- Evaluate the potential for solidifying/stabilizing combustion ash from MSW incinerators.
- Determine if technology is available or can be developed to recover usable materials from ash.
- Conduct comparative analysis of constituents in ash.
- Provide information and tools necessary to monitor, evaluate, and control individual municipal waste combustors.
- Evaluate the impact of MSW plastic on emissions and ash characteristics.
- Characterize pilot-scale and full-scale benefits of improved combustion techniques on lessening the formation of dioxins and furans.
- Evaluate co-firing technologies in various combustion facilities such as coal burning boilers, cement kilns, etc.
- Determine the effect of removing metals and glass from the MSW waste stream prior to combustion on mass burning equipment and combustion efficiency.

E. LANDFILLING

Landfills continue to be the cheapest technique, in most cases, for disposing of large volumes of municipal solid wastes. However, it is usually difficult to site new landfills. Landfills have received a substantial amount of bad press from those facilities that have been poorly designed, operated, and closed. While a substantial amount of research has been done, there are still areas that require additional work. This additional research, in part, encompasses utilizing the information gained in development of control technologies in the hazardous waste disposal program and adapting these control technology methods or modifying them to meet the requirements of a MSW landfill.

The following research programs should be developed in order to increase landfill reliability and acceptance:

- Conduct research on the type and quantity of air emissions escaping from MSW landfills, and determine future needs to monitor and control.
- Assess using MSW landfills as large bioreactors to accelerate decomposition.
- Validate the use of lime/flyash injection into MSW landfills for Solidification/stabilization and minimize pollutant release.
- Develop a guidance document for corrective action of control technology systems constructed at MSW landfills.
- Evaluate cost/effectiveness and need for various landfill liners.
- Assess costs involved in post-closure care of landfills.
- Perform an inventory of existing mine sites that are disposing of MSW; evaluate siting problems, costs, handling, placement, and performance; update the economic study of rail haul for disposal of MSW in mine sites.

F. SPECIAL WASTES

All of the special wastes discussed have individual human health and environmental concerns associated with their disposal on the land. The following research needs to be initiated for the wastes identified below:

(1) Tires

- Evaluate pilot-scale and full-scale tire combustion processes for economic viability and environmental adequacy (an example would be the Modesto, California tire incineration facility).
- Update information on the usage of reclaimed rubber tires in road construction.
- Evaluate cost and environmental effects of shredded tires in landfills.
- Survey the shredder/incinerator facilities now being developed, and assess their effectiveness.

(2) Autos

- Develop new or improved methods of handling potentially hazardous materials from abandoned auto bodies.
- Develop national data on the destination of autos not captured by the recycling industry.

(3) Batteries

- Characterize MSW with respect to lead (post versus current).
- Perform fate and transport studies of lead in landfills.
- Evaluate the costs, potential effectiveness, and environmental impacts of recycling household batteries.

(4) Infectious Wastes

- Characterize/quantify infectious waste generation and management practices.

Institutional and hospital wastes need to be accurately characterized and quantified in order to properly dispose of them. Management practices for these wastes also need to be examined and evaluated in order to determine the best form of disposal. This activity will be undertaken by state governments.

- Perform a risk assessment of common infectious waste management methods.
- Develop and evaluate effective handling and disposal techniques for placement of infectious wastes in MSW landfills.

The specific disposal practice of landfilling infectious wastes needs to be optimized for factors such as handling and transport of wastes to the landfill, breakage of infectious-waste-filled bags, possible spills of liquid infectious wastes into the landfill, etc.

(5) Sludge

- Determine fate and effects of organics in landspreading of municipal sewage sludge.

After the above-mentioned research is completed or in process, the landspreading of sludge needs to be reevaluated. This evaluation will take into account the various effects and hazards of chemical constituents in sludge and determine the benefits/liabilities of landspreading.

- Determine the beneficial and negative effects of codisposal of sewage sludge with MSW in landfills and in municipal waste combustion.

(6) Demolition and Construction Wastes

- Determine the quantity of these wastes being disposed in MSW landfills in order to determine the impact of these wastes on landfill capacity.

This activity is recommended because no study or survey of its kind has ever been conducted and, therefore, little, information is available in the literature. By accurately determining amount of wastes disposed, the burden of these wastes on landfill capacity can be more accurately estimated.

- Evaluate human health and environmental impacts of demolition and construction waste management practices.
- Evaluate disposal methods for asbestos-containing demolition wastes.

(7) Household Hazardous Waste and Very Small Quantity Generator Wastes (HHW and VSQG)

- Perform a survey on HHW/VSQG generation and disposal. Also, determine whether household hazardous waste and very small quantity generator wastes have a significant impact on the composition of leachates from landfills or emissions from municipal waste incinerators.

This activity can be conducted by various states who wish to quantify/verify the need for separate waste collection programs.

G. RISK ASSESSMENTS

Emissions from MSW disposal sites enter a variety of media, including surface and ground waters, soil, and air. Exposure may be intermittent and the components of the mixture may interact and even change over time. Research needs include media-specific identification and characterization of toxic components, a broad-based program of research on the health risk of chemical mixtures and exposure to toxic substances where exposure is intermittent or episodic. Earlier in this chapter, the need for certain waste and technology-specific risk analyses has been noted. Therefore, the following research needs may overlap with those identified earlier.

- Determine exposure through air, soil, sediment, water, and agricultural products from municipal waste combustors, landfills, and compost facilities.

This is a series of exposure assessments which will form the basis for determining the environmental risk of various alternatives and comparing them.

- Determine exposure through recycled materials (secondary materials).

Determining human health exposure to hazardous constituents that may be contained in recycled materials may eliminate the idea that recycled materials may pose a health threat to those who use them (e.g., have all viruses been removed from recycled material?). This will also help industry produce a "safer" product if, in fact, these recycled materials do pose an exposure risk.

- Research to study the impact on safety and health of materials processing and recycling facilities (i.e., household hazardous waste, lead-acid batteries).

This activity is crucial to risk assessment because it forms the basis of irrational fears in citizens who either volunteer to work at the facility or live close to the facility. If there is a chance that human health is at a risk by working in a recycling facility, governments and industry must design or change the existing process in order to ensure no significant human health risks will be present. Therefore, a long-term study of risks associated with materials processing and recycling facilities is necessary to answer these questions.

In summary, these are some of the more important research, development, and demonstration projects to support a strong MSW management program nationwide. The sponsors of such a program would be a combination of EPA, the Department of Energy, the Department of Agriculture, trade associateions, industry groups, and institutional research foundations.